plating

JOURNAL OF THE AMERICAN ELECTROPLATERS' SOCIETY

IN THIS ISSUE

The Tarnish Resistance of Gold Plating Over Silver

Hydrogen Embrittlement of Cadmium Plated Spring Steel

Zinc Plating of Carbonitrided Steel

Constant Wattage Hard Anodizing of Aluminum

AES's Coming Pilgrimage to New England's Citadel of Science

PLATING MAGAZINE

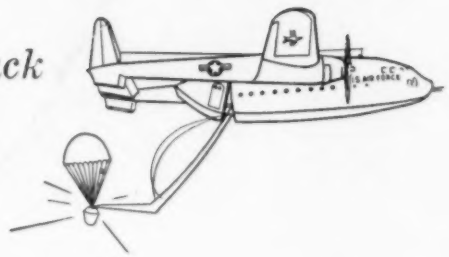
AMERICAN ELECTROPLATERS' SOCIETY

AUDITED PAID CIRCULATION ABC

University Microfilms
313 N. First St.
Ann Arbor, Michigan

OCTOBER - 1960

finding the golden needle in the haystack



(Top right) *sketch illustrates mid-air catch of returning Discoverer XIV nose cone snagged by an airplane-towed "skyhook."* (left) *A captured practice capsule is slowly reeled towards the rear opening of airborne C-119 Recovery Plane.*

NOSE CONES PLATED WITH SEL-REX BRIGHT GOLD* RECOVERED FROM SPACE ORBITS!

Orbiting the globe, then returning earthward upon signal, Discoverer XIV's space capsule plummeted home to be snatched from the heavens in an historic mid-air catch!

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(Above) *President Eisenhower holds American flag which was in recovered capsule during its flight through space. Capsule shown was electroplated with patented Sel-Rex Bright Gold Process. With the President are General Thomas D. White, Air Force chief* (center) *and Col. Charles G. Mathison, who directed the "capsule chase."*

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Patented processes for plating with Gold, Rhodium, Platinum, Paladium, Silver, and to produce "custom alloys" for your particular requirements.

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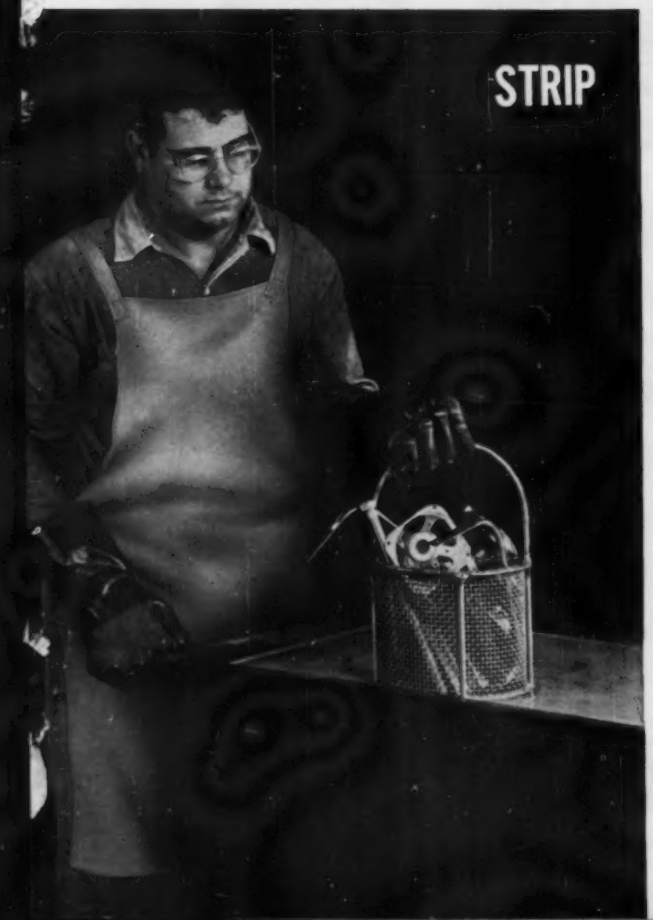

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A ready-to-use nickel stripper for only nickels per pound

Newly-developed Enstrip S-60 is a ready-to-use nickel stripper which costs only nickels, not dollars, per pound. And for this low price you also buy convenience, savings in labor. No electric current is required with Enstrip S-60. Just weigh it out, dissolve in water and start stripping nickel, copper, brass, zinc, cadmium or silver plate from steel, iron alloys, magnesium. The powdered alkaline compound, containing cyanide, dissolves faster than metal strippers to which cyanide eggs or bricks must be added.

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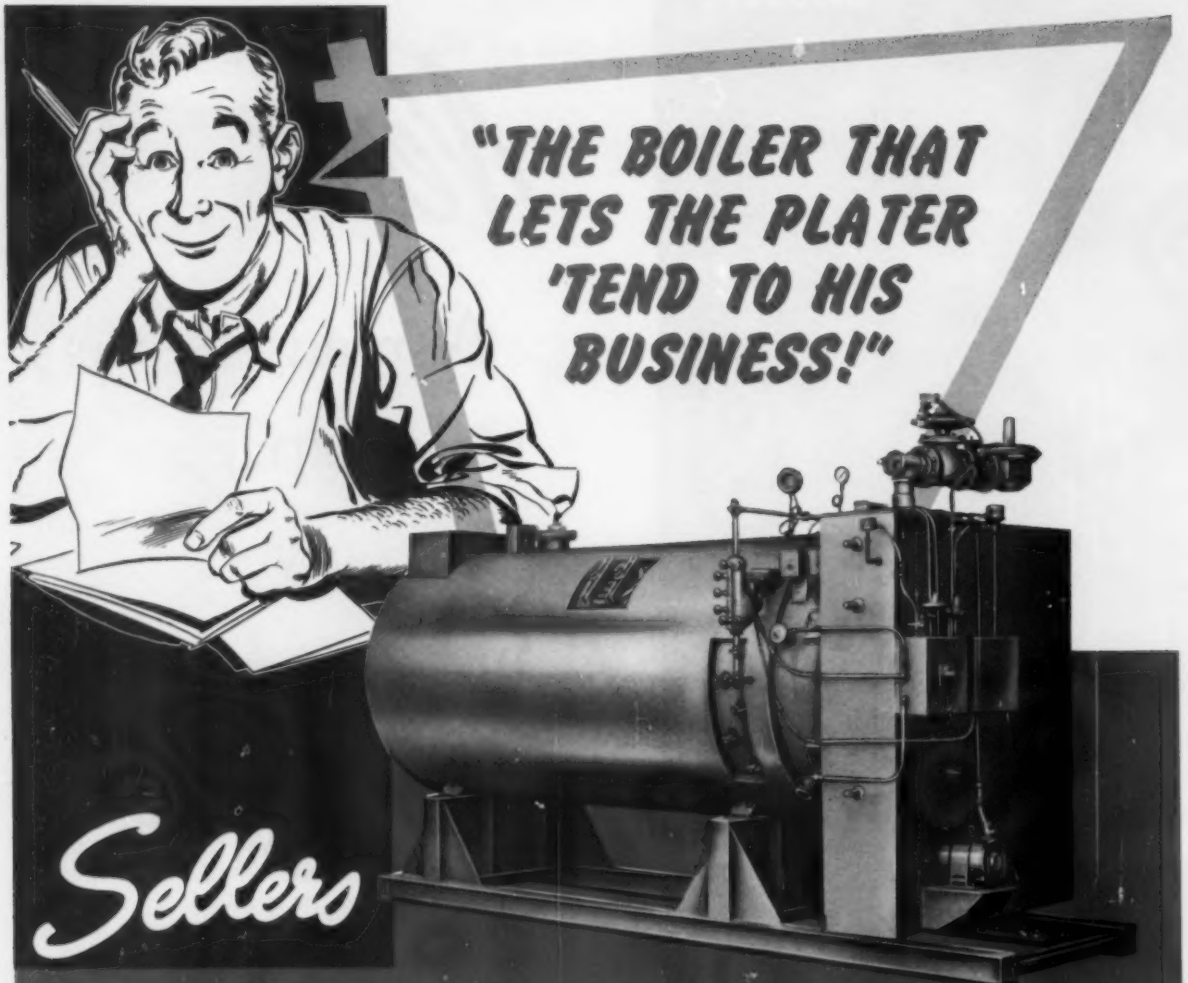

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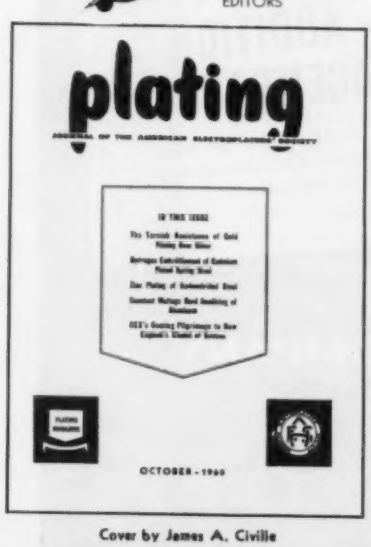

Cover by James A. Civille

plating

JOURNAL OF THE AMERICAN ELECTROPLATERS' SOCIETY

OCTOBER 1960 — **Vol. 47, No. 10**

EDITORIAL

Finding Knowledge 1115
by Chester G. Borlet

The Tarnish Resistance of Gold Plating Over Silver 1141
by William B. Harding

Hydrogen Embrittlement of Cadmium Plated Spring Steel 1146
by J. A. Gurklis, L. D. McGraw and C. L. Faust

Zinc Plating of Carbonitrided Steel 1155
by Leonard R. Kohan and Howard T. Francis

Constant Wattage Hard Anodizing of Aluminum 1159
by Martin A. Blumenfeld and W. Fred Schurig

AES's Coming Pilgrimage to New England's Citadel of Science 1174

Japan's Plating Industry Viewed by Blount 1180

AES Directory	1215	Industry News	1186
AES Membership Report	1212	Industry News Briefs	1190
AES News	1169	Index to Advertisers	1216
Article References	1199	Intersociety News	1178
Branch News	1211	Patent Abstracts	1192
Classified Advertisements	1213	Personals	1204
Equipment and Supplies	1201	Trade Literature	1136
Future Meetings	1214		

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EDITORIAL

FINDING KNOWLEDGE

HIS NAME MOMENTARILY escapes me but someone wise once said, "To lack knowledge is no disgrace. To lack the desire for knowledge is a pity. But to desire knowledge and not know how and where to find it is a tragedy".

The business of American Electroplaters' Society (AES) is to facilitate education in the arts and sciences of electroplating, metal finishing and allied arts. Through full and good use of the tools for enhancing knowledge, AES has consequently afforded opportunity to thousands and thousands of mature as well as younger men and women over a stretch of a half-century to gain, develop or sharpen knowledge for self improvement.

Three AES echelons purvey knowledge. AES's National Conventions, its Research Program, its PLATING MAGAZINE, its TECHNICAL PROCEEDINGS, to name a few, are among AES's educational tools at national level. The Annual Educational Sessions of AES's various Regions and Area groups are among the educational media employed at district level. The annual and particularly the monthly Branch educational meetings are among the vital educational tools used at Branch level. And since the monthly Branch educational meeting affords AES's members with most direct, frequent and intimate exposure to technical education, it is consequently of vital importance to the Society's educational mission.

In many of AES's 59 American, Canadian and Australian Branches, the monthly educational meeting has earned a high estate of meaning and effectiveness. The Society's goal is that top standard shall be attained by *all* AES Branches. And to this end, its Public Relations Committee, after a full year's study, has completed a statement of 16 suggestions that has not only been issued to all AES Branches by National Headquarters but also published in full in the August 1960 issue of PLATING MAGAZINE (Page 944).

One large and burgeoning AES Branch's use of that statement, for example, is worthy of comment here. That Branch has vested the responsibility of providing its members with top-grade education at monthly Branch meetings by appointing a Branch Educational Chairman and two qualified assistants. It has conducted a well-planned and well-executed poll of its members to determine exactly what type of technical knowledge is needed in that particular Branch. By employing the AES Speakers List to the end of obtaining qualified speakers on those particular areas of technical interest, it hopes to offer Branch meetings wherein its members can indeed find knowledge in the areas of their personal interest.

The recent formation of the AES's Far West Educational Council via which the Society's five Pacific Coast Branches have now banded together to stimulate even greater traffic of qualified technical speakers is but another example of the AES's concentrated drive to upgrade Branch educational meetings to an even higher plane of performance, so that those thirsting for knowledge in electroplating, metal finishing and allied arts will, in *all* AES Branches, find it.

Chester G. Borlet

First Vice President
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For extreme accuracy in masking parts for all plating cycles.

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Provides complete masking protection for hard chromium plating.

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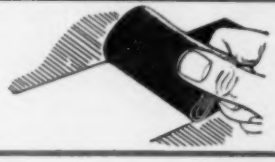
A special lacquer that can be peeled easily from parts after all plating cycles.



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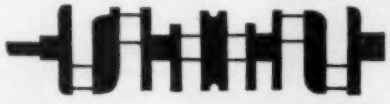

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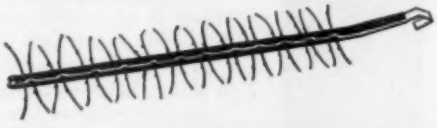

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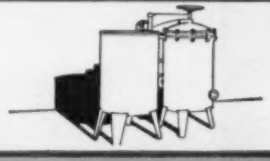

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In expressing its appreciation to YOU, its regular advertisers, for this proved confidence in it as a medium for bringing YOUR sales promotion story to the electroplating, metal finishing and allied arts market, PLATING MAGAZINE also invites, most cordially, those of this field's advertisers who have not yet adequately sampled PLATING advertising, to weigh well, on merit, PLATING MAGAZINE's prestige, circulation, readership coverage, readership constancy, space rates and other values when preparing their 1960-1961 advertising budgets and schedules.

This is one of the principal reasons why PLATING MAGAZINE has published the little booklet whose two-tone cover is pictured above—so that, from its illustrated, simply written pages, such advertisers can determine for themselves as to whether it is of dollars and cents importance to them TOO to use PLATING MAGAZINE's advertising columns regularly and to maximum extent.

Copies of the booklet have already issued to many representative companies and their advertising agents with whom PLATING indeed desires to create and cement such a relationship. If through some mischance YOUR copy has not yet reached you, please write us. Without obligation or cost to you of any sort, a copy will promptly be sent for study and action by YOU the advertiser.

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Quality

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Zero-Mist can mean cost savings for you.

There is sound reason for the steady increase in the use of Udylite Zero-Mist over the past six years. Users everywhere have learned that here is the *one* mist suppressant that actually *does what it's supposed to do.*

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- Eliminate *completely* the health hazard of dangerous chromic acid mist . . . it beats the most stringent code limitations.
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- Avoid permeating the outside air with destructive fumes.
- Eliminate contamination of adjacent baths.
- Sharply reduce costly waste disposal.
- Reduce equipment maintenance.

Before you invest in expensive air wash ventilation and blower equipment, ask your Udylite man what Zero-Mist can do for you.

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detroit 11, michigan

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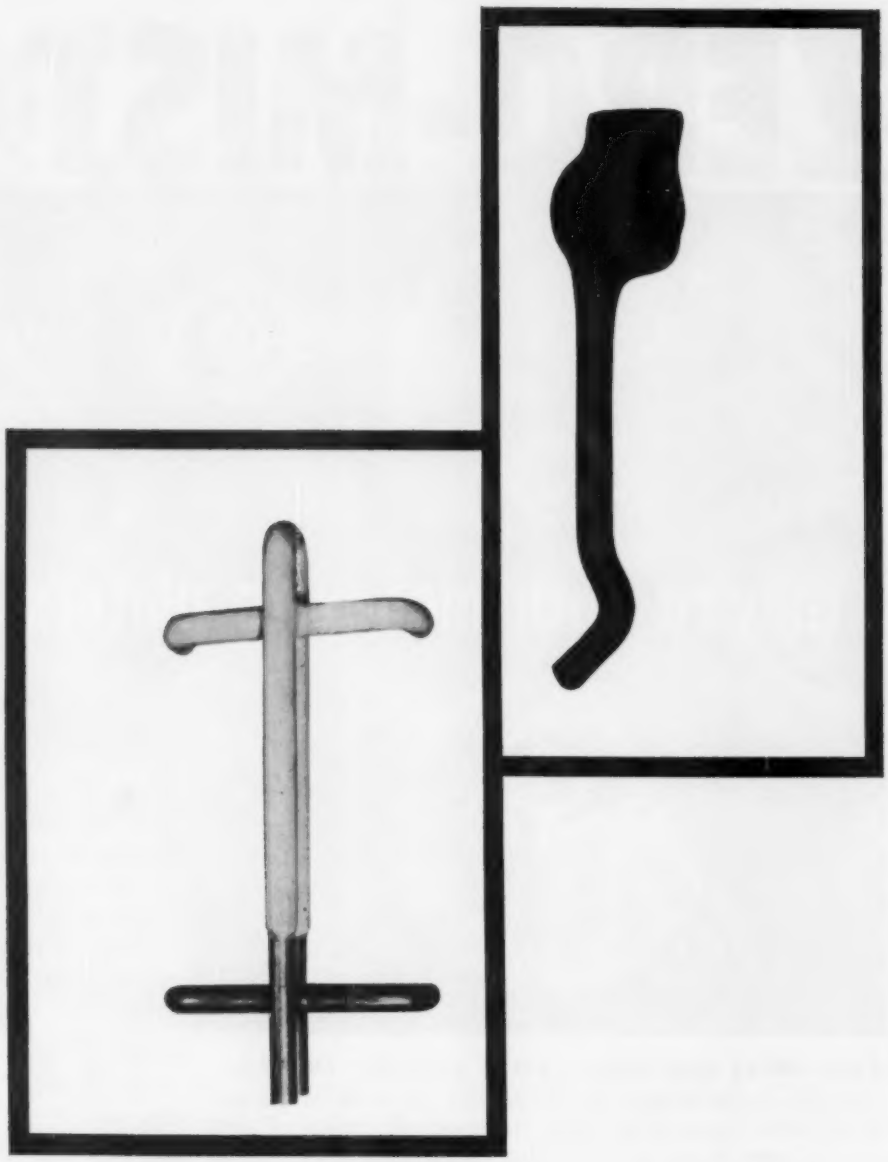

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If you use plastisol coatings for your plating racks...you owe it to your profit-and-loss statement to check on Reynosol. You'll find that longer life and better service are built into your own Reynosol coating. You'll find, too, that a plastisol coating specially formulated to suit your specific needs costs no more...and perhaps less than you are paying now for plating rack coatings. Write or call Reynolds Chemical today. It'll pay off in higher net profits...and smoother dipping operations.

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- ★ absolute soundness . . . freedom from defective components.
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- ★ your unit fully checked out . . . ready to hook up and go to work.

To gain this truly comforting assurance choose Udylite Rectifiers, the finest electrical equipment, designed expressly for the plating industry by Udylite. Check with your Udylite man or write to:

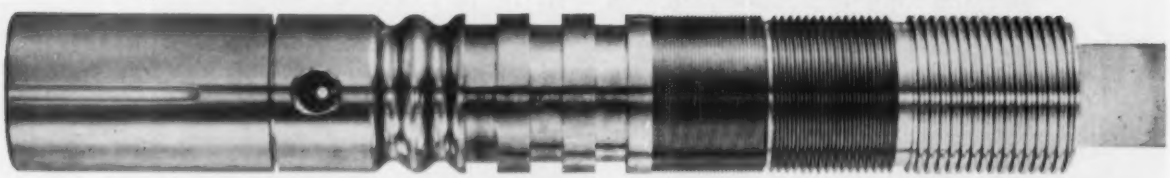
the udylite corporation

detroit 11, michigan

on the west coast: L. H. Hutcher Co.

THEY LAUGHED WHEN WE SAT DOWN TO PLATE...

they didn't know about KANIGEN®



This shaft was turned. It was key-slotted, drilled, tapped and shouldered. It was threaded, milled, grooved and chamfered. It was step-bored, with three inside diameters. Who could plate a piece like this all over—inside and out—and expect a uniform coating?

Well, anyone who used KANIGEN® could expect it—and get it. In fact, we made this piece especially to prove it.

The KANIGEN® process for chemical nickel alloy plating produces a uniform thickness of coating, regardless of the contours of a part. This uniformity permits full machining operations prior to coating, with no subsequent cleanup.

KANIGEN® offers corrosion resistance equal or superior to that provided by wrought or electrolytic nickel.

For complete technical details write or call your nearest General American office. Ask for Kanigen Bulletin No. 258. You'll find that with plating as in so many other industrial areas, *it pays to plan with General American.*

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

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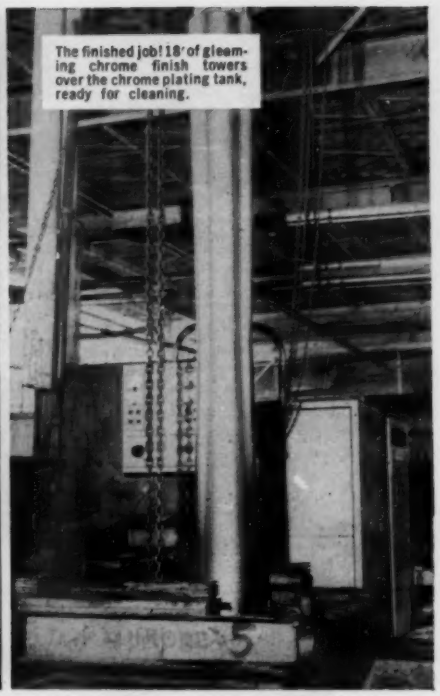
KANIGEN GENERAL AMERICAN TRADE MARK

Skilled plater washes down a giant roller for aluminum mill as it is slowly withdrawn from a deep chrome plating tank containing Mutual® Chromic Acid.



The finished job! 18' of gleaming chrome finish towers over the chrome plating tank, ready for cleaning.

Simmons Vertically Plates 18′ Roller For Aluminum With MUTUAL CHROMIC ACID

Being *vertically* chrome plated for use on the world's largest rolling mill — a 170-inch-wide reversing mill at the Reynolds Metals Company Alloys Plant, Listerhill (Sheffield), Alabama—are giant steel rollers for carrying aluminum ingots.

The Simmons Plating Works of Atlanta, Georgia immerses each roller in a 28′ deep chrome plating tank containing Mutual Chromic Acid. The vertical plating process provides a faster, better quality plating job over the entire surface of the roller. Each roller is plated to .005″ minimum thickness in a standard 33 oz. per gal. chromium plating solution at normal plating temperatures of 130°F.

Like many other skilled platers throughout the country, Simmons relies on high purity Mutual Chromic Acid to provide a chrome plate that gives longer wear and resistance to rust and corrosion. Plating with Mutual Chromic Acid also helps to protect the rollers from damaging or scratching the aluminum ingots they convey.

Mutual Chromic Acid is always 99.75% pure—or better. Sulfate content never exceeds 0.1%. Rigid quality control insures that the chromic acid you get is always the same. This makes it easier for you to control accurately the chromic acid-sulfate ratio of your plating bath.

For information on Mutual Chromic Acid, as well as other Mutual chromium chemicals, send coupon for our free booklet, "Chromium Chemicals." Our Technical Service staff will also be happy to answer your questions.

OTHER PRODUCTS FOR PLATERS
SOLVAY® Caustic Potash • SOLVAY Caustic Soda
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Allied Chemical

SOLVAY PROCESS DIVISION
61 Broadway, New York 6, N. Y.

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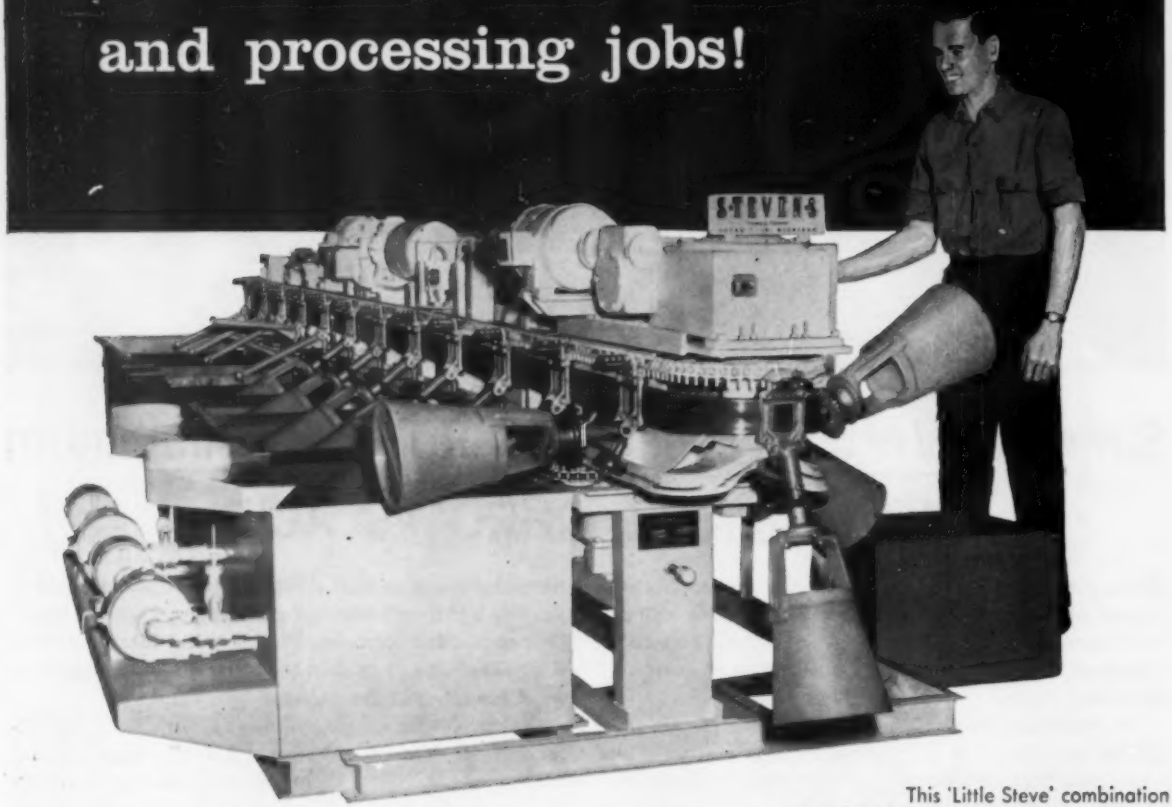
Now there's a member of the famous 'LITTLE STEVE' family to handle ALL your plating and processing jobs!



This 'Little Steve' combination Barrel and Basket Machine was designed to bright dip small electrical control components in small batches at a 120-barrel-per-hour rate within rigid space limitations. Parts require top quality finish to close tolerance; Little Steve' is only 23 feet long, 6¾ feet wide and normally, 4 feet high.

'Little Steve' automatic barrel machines

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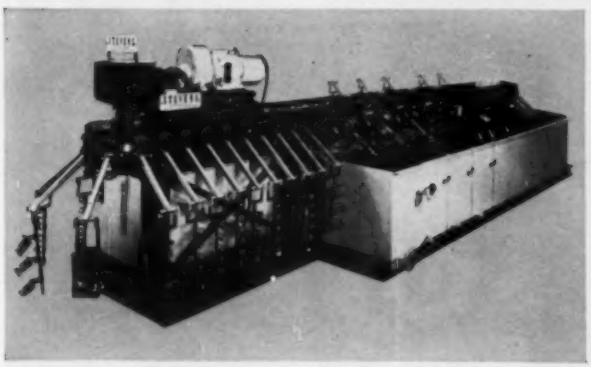

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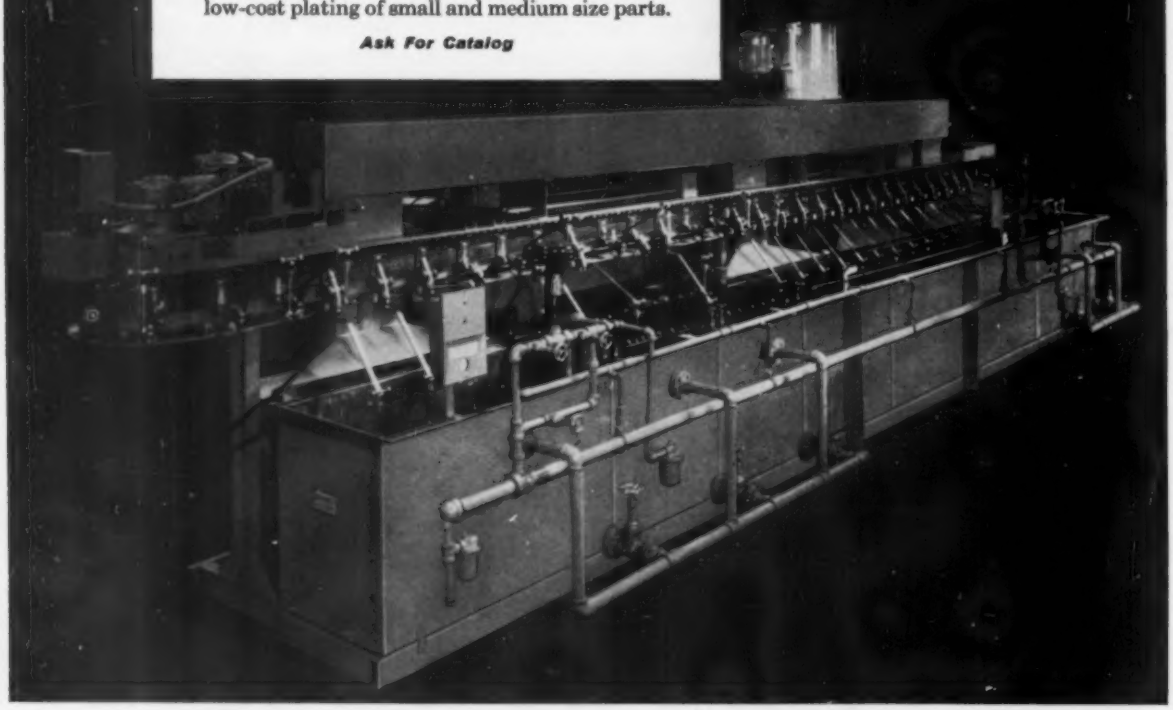

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The unique book contains the full text of each of the 43 technical papers on electroplating, metal finishing, organic coating and allied arts by experts of nine countries, including the United States, England, Canada, Australia, France, Germany, Holland, India and Italy, delivered before the Fifth International Conference on Electrodeposition and Metal Finishing, educational sessions element of the AES's Golden Jubilee Convention held in Detroit, Michigan, June 15–19, 1959.

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GREETED by the President of the United States, the AES was welcomed to Michigan and Detroit by Governor G. Mennen Williams. The entire week of the AES's Convention, Exposition and International Conference was proclaimed by Detroit's Mayor as "AES GOLDEN JUBILEE WEEK IN DETROIT."

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UNDER the supervision of the AES's Editorial Board, in collaboration with the International Council on Electrodeposition and Metal Finishing, the International Conference was planned for the AES by AES Past President Walter L. Pinner, Chairman of the International Council. His Committee included Dr. T. P. Hoar, Dr. Simon Wernick, A. W. Wallbank, R. A. F. Hammond and George Gardam of England and Myron B. Diggin, Dr. Walter R. Meyer and Dr. Richard B. Saltonstall of the United States.

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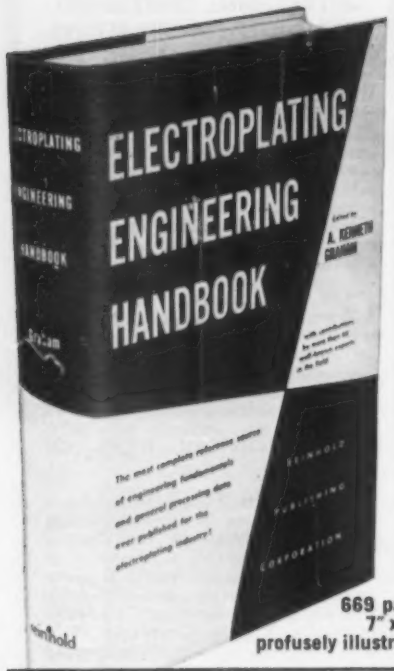

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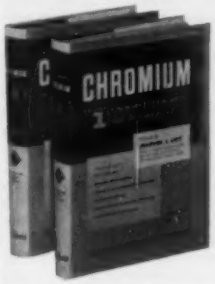

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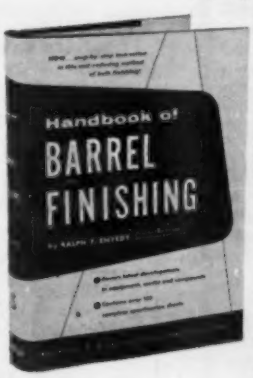

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TRADE LITERATURE

L—1001. SPRAY GUN—The availability of an illustrated bulletin describing the recently developed Ionic electrostatic hand spray gun with the new electrocentrifugal dispersion technique has been announced. The bulletin illustrates and describes in detail the design application of the hand spray gun Model 10.

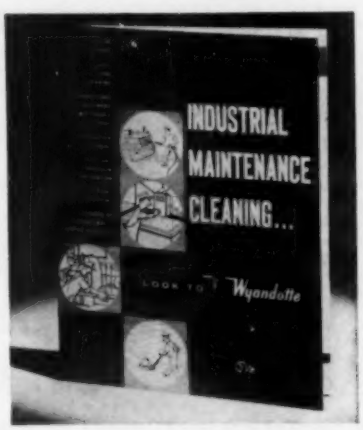
The new gun utilizes the basic principles of electrostatic spraying but preatomizes the paint particles by powerful turbine-driven centrifugal action. This entirely new principle makes "wrap-around" coverage possible for metallic as well as non-metallic paints and extends the application of electrostatic methods to a great many other paints without requiring special formulation.

L—1002. WORK GLOVES—The Glove Division of the Riegel Textile Corp. is now offering a new selector manual covering basic types and styles of work gloves. The guide is complete with information on basic cuts, cuff styles and other specification detail. It contains tips on many points such as grades of leather, chemical resistance and physical properties of various plastic coatings. Basic features of canton flannel, jersey, leather, terry cloth, neoprene, plastic and rubber coated, hot mill and welders are all covered.

L—1003. PRODUCT SELECTOR—Macco Products Co. has just issued a new products selector brochure.

The pocket-size brochure tells how to select cleaners, cutting lubricants, drawing compounds, rust preventives, forging compounds, and extrusion lubricants, and lists 46 different compounds in the above categories to simplify selection by pin-pointing to specific applications.

L—1004. INDUSTRIAL CLEANING—Six full pages of concise information on Wyandotte products for heavy-duty Industrial Maintenance Cleaning are presented in a colorful, illustrated folder F-2961-A just released by J. B. Ford Division, Wyandotte Chemicals Corp.



Catalog-style layout with prominent illustrations, section headings and product names make it easy for the reader to locate desired information.

Folder is divided into sections that provide detailed information on Wyandotte products for machinery and equipment maintenance, circulation cleaning, hot soak tank cleaning, steam cleaning and paint-stripping.

L—1005. FILTER SYSTEM—Sethco Manufacturing Corp. has issued Bulletin No. 651 which describes their new XAL 'in-tank' filter systems with detachable full-view filter chambers.

Designed for use in precious metal plating departments as well as research laboratories having small plating tanks, these compact units are claimed to be com-

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L—1006. GOLD ELECTROPLATE MEASUREMENTS—Latest techniques for controlling and measuring thickness and hardness of precious metal electroplates, with particular emphasis on gold, are discussed in an original technical paper by Mrs. Grace Wilson, laboratory technician, Sel-Rex Corp.

Precise engineering applications for precious metal electroplates in industry are reviewed, and the importance of close control of the thickness and hardness of such coatings is discussed. The three-page illustrated article points out the necessity of understanding in depth the techniques involved.

The paper also lists a step by step procedure for the preparation of electroplated specimens, and equipment needed for the measurements. Reprints of Thickness and Hardness Measurements on Gold Deposits are available free of charge.

L—1007. BARREL FINISHING COMPOUND—A new, alkaline compound for cleaning, descaling and shine-rolling small steel parts, has been announced by Frederick Gumm Chemical Co.

CLEPO 11-T consolidates multiple cleaning, pickling and shine-rolling processes into a single operation. After tumbling steel parts in the new compound for 15–45 minutes, the metal surfaces are claimed to be completely cleaned and burnished. The work can then be water rinsed and barrel plated. This unique product thereby eliminates operations and reduces labor and material costs. Technical Bulletin 660-A describes the new product and is available on request.

L—1008. CLEANER-PHOSPHATIZER—Development of a new phosphating compound for simultaneous cleaning and phosphating of iron, steel and zinc called Paintite has been announced by Turco Products, Inc.

Applied by immersion, spray washer or steam cleaner, the cleaner is said to produce a light (up to 70 mg/sq ft), very tight, smooth and uniform phosphate coating, assuring paint adhesion and preventing the rapid postrusting of metals before painting. It is low foaming, low sludging and free rinsing, and requires a minimum of temperature control when used between 140–180F.

L—1009. FINISHING SILVER PLATE—A new technical data sheet on decorative finishing of silver plated articles has been made available by The Lea Manufacturing Co. Types of finishes covered are hammered, satin, bright and dull butler, oxidized, semi-mirror, mirror and ultra-mirror. Data includes abrasive compound grades, buffing wheel speeds and operating instructions.

L—1010. ULTRASONIC CLEANING—Comprehensive information on the advantages of ultrasonic cleaning is contained in a new bulletin, "How to Clean Ultrasonically with Self Tuning," offered by Powertron Ultrasonics Corp.

Written by top Powertron engineers, the bulletin provides a basic explanation of how ultrasonics works, what it can do to cut time and labor costs, and a guide to the selection of tank and generator sizes for various jobs. A discussion of Powertron's new development, the Autosonic line of self tuning cleaners, is also included.

L—1011. TAPE ANALYZER—A 4-page, color bulletin on the new Graver automatic tape analyzer is available from Graver Water Conditioning Co., a division of Union Tank Car Co. The bulletin, WC-127, covers all facets of the unit, including method and principle of operation, potential applications and basic specifications for the instrument, and the Millipore Filter® tape used as the testing medium. It also gives design data, including components and materials of construction. Copies of the bulletin are available from Graver without obligation. The analyzer, recently introduced, is an instrument for continuously measuring the level of trace insoluble solids in liquids.

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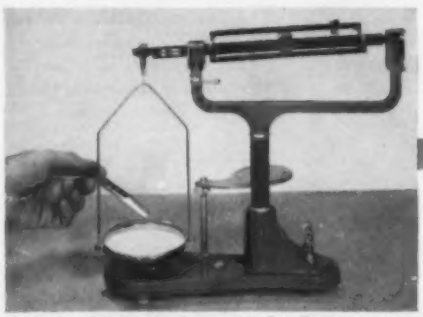
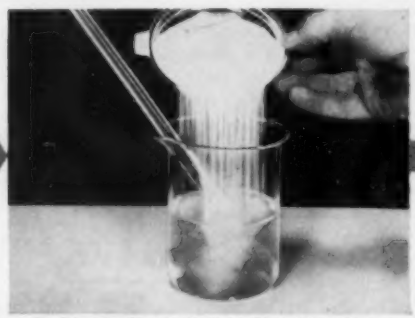


1 Just weigh required amount of sodium-copper or potassium-copper double salt.



2 Dissolve the desired double salt in water or plating solution.

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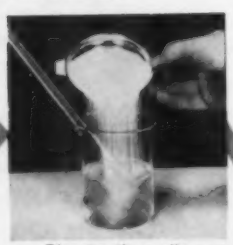
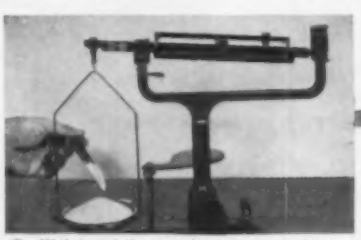


2 Dissolve the sodium or potassium cyanide in water.



3 Weigh out the required amount of copper cyanide.

4 Add copper cyanide to water and make a slurry.

5 Dissolve the copper cyanide slurry in solution of sodium or potassium cyanide.

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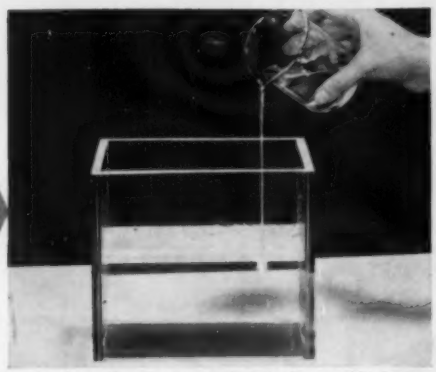

3 Add directly to plating tank—no filtering necessary.

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Copper	25.8%	26.3%
"Free" potassium cyanide	1.25% to 3.0%	2.9%
Lead	7 ppm. max.	Less than 1 ppm.
Sulfides (as sulfur)	10 ppm. max.	Less than 5 ppm.
Insolubles	0.01% max.	Trace

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Fig. 1. Photograph of silver and gold plated part showing overall type of tarnish. Black circles are through holes. The photograph is about one-half size.

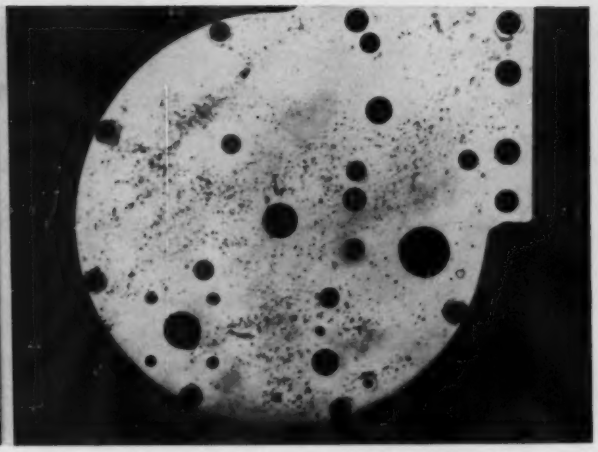


Fig. 2. Photograph of silver and gold plated part showing spot type of tarnish. Black circles are through holes. The photograph is about one-half size.

THE TARNISH RESISTANCE OF GOLD PLATING OVER SILVER

by **WILLIAM B. HARDING***

ABSTRACT

Gold plating in thicknesses of as much as 0.2 mil is frequently applied over silver plating to protect the latter from tarnishing. However many instances of tarnishing of parts so plated have occurred. An accelerated exposure test was devised that will duplicate the tarnish and a quantitative method of evaluating the degree of tarnish was developed. Tests of 300 plated panels showed that gold plating 0.2 mil thick over silver is sufficiently porous to allow tarnishing to occur, and that in order to produce a reliably non-tarnishing surface, 0.4 mil of gold is necessary. It is recommended, therefore, that in applications where tarnishing cannot be allowed that silver plating be eliminated and gold alone used.

INTRODUCTION

SILVER PLATING is widely used in electrical and electronic designs because of the metal's excellent electrical characteristics. Silver has, however, the well known property of readily tarnishing in the presence of sulfur and sulfur bearing materials. Since the atmosphere and many materials frequently contain sulfur, the formation of tarnish on silver is to be expected.

In those applications of silver where the formation of tarnish is undesirable and where it is wished to retain an electrically conductive and/or readily solderable surface, it has often been the practice of designers to specify a final thin gold plate. The Kansas City Division of the Bendix Corporation has produced and procured millions of parts plated in this manner on which the thickness of the gold plating used has varied from as little as 0.02 mil to as much as 0.2 mil and more. Despite the use of the gold plating, however, a considerable amount of tarnishing of parts has occurred.

Two types of tarnish have been encountered:

1. A general overall tarnish varying from reddish through purple to dark blue. The appearance sometimes is as if someone had swabbed the surface with purple ink. Figure 1 is an illustration of this type.
2. A "spotting out" type of tarnish. This has been the most common. It consists of from a few to a large number of small spots, light to dark brown to black in color. Figure 2 is an illustration of this type.

The appearance of the first type of tarnish strongly indicates that it is caused by residual salts on the surface. The occurrence of this type of tarnish has been eliminated through careful attention to the rinsing procedure following the gold plating.

The appearance of the second type of tarnish suggests that it is a bleeding of material from pores onto the surrounding surface. Microscopic examination of a spot usually reveals a small pore in the center. The spots run about 0.005 to 0.02 inch in diameter and the pores about 0.0007 to 0.003 inch. Because of the similarity in appearance to spotting out, it was believed at first that this type of tarnish was caused by a similar mechanism; that is, trapped salts in a pore will absorb water from the air producing a solution that wells out of the pore onto the surrounding surface. If the salts are cyanides, as they most likely would be, they may dissolve some of the underlying silver and bring it to the surface where in time silver sulfide will form. If this is the mechanism, then this

*Senior Materials Engineer, The Bendix Corporation, Kansas City Division, Kansas City, Missouri.

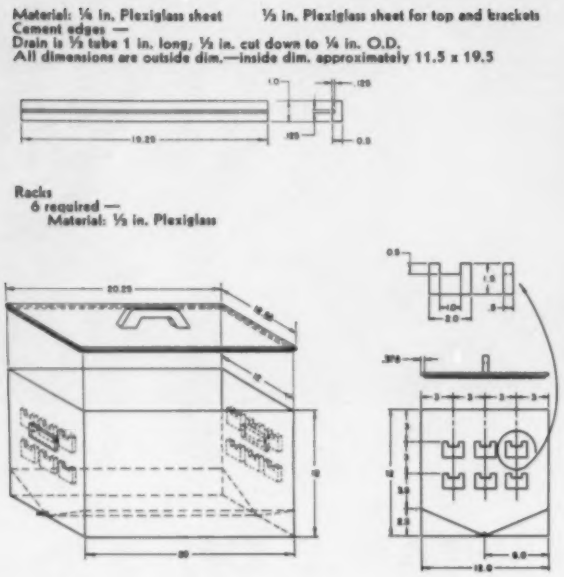
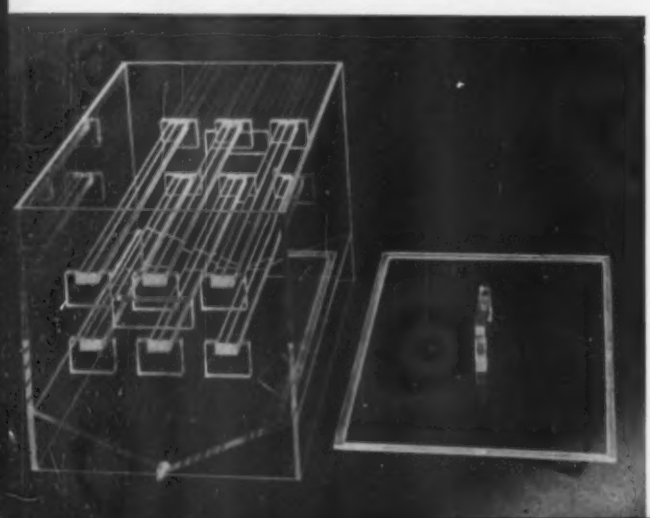

Material: ¼ in. Plexiglass sheet
½ in. Plexiglass sheet for top and brackets
Cement edges —
Drain is ½ tube 1 in. long, ½ in. cut down to ¼ in. O.D.
All dimensions are outside dim.—inside dim. approximately 11.5 x 19.5
Racks
6 required —
Material: ½ in. Plexiglass

Fig. 3. Sketch of artificial exposure chamber.

type of tarnish should be eliminated by improving the final rinse following gold plating. Special rinsing procedures including alkaline cleaning, neutralizing dips in dilute acetic acid, and soaks in near boiling deionized water, were found to reduce the incidence of the spotting, but they would not eliminate it. It was evident then, that although poor rinsing contributed to tarnish formation other factors were involved.

Egan and Mendizza[1] found that in the presence of sulfur vapor, silver sulfide will creep from a silver surface over an adjacent gold surface. This appears to explain the rest of mechanism of spot formation. Silver sulfide formed at the base of a pore through the gold creeps up and out over the gold surface. If this is the case, then only a completely non-porous gold deposit will reliably prevent the tarnishing of silver. A study was begun, therefore, to determine the minimum thickness of gold plating that is non-porous and to compare the porosities of deposits from various sources. It was also hoped that the factors in the plating process that contributed to the porosity would be pinpointed.

Fig. 4. Photograph of artificial exposure chamber.



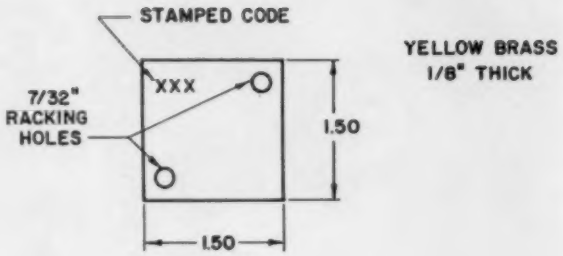


Fig. 5. Sketch of standard test panel.

DEVELOPMENT OF TARNISH TEST

The first step was to develop an accelerated test that would reproduce the type and degree of tarnish observed in practice. The Orchard Paper Company of St. Louis, Missouri, described in a letter a test used to evaluate the effectiveness of tarnish inhibiting paper. The test involved wrapping a silver plated test panel in the paper and exposing it in a closed chamber to the atmosphere formed over a dilute solution of ammonium sulfide. Initial work using a glass desiccator as an exposure chamber showed that exposure of this type would, in 4 to 6 hours, reproduce exactly the appearance of the spot type tarnish. This was encouraging and it was decided, therefore, to perform a dual study of the test and of the tarnish resistance of gold plating. The aid of other interested organizations was enlisted in order to determine the reproducibility of the test.

A special exposure chamber was designed and six were built. Figure 3 is a sketch of the chamber giving its dimensions and Fig. 4 is a photograph of a finished chamber. The chambers were made of transparent, colorless, Plexiglass to allow the observation of a test in progress.

The exposure tests were run as follows:

1. Plated test panels were cleaned in reagent grade isopropyl alcohol, dried and mounted in the chamber by placing them upright in the grooves of the horizontal racks.
2. The lid was put in place and 200 ml of a 0.2 per cent solution of ammonium sulfide, $(NH_4)_2S$, was admitted by means of a funnel and rubber tube through the inlet hole at the bottom of the chamber. The lid was cracked momentarily to allow the pressure to equalize.
3. The exposure was carried out for 5 hours after which length of time the panels were removed, dipped in distilled water, reagent grade isopropyl alcohol, and dried.

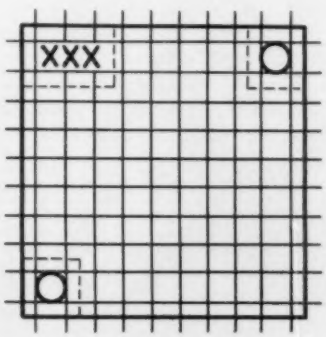


Fig. 6. Simplified illustration of image of panel projected upon grid.

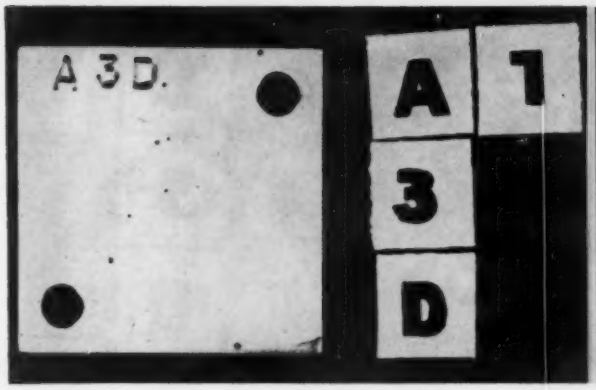


Fig. 7

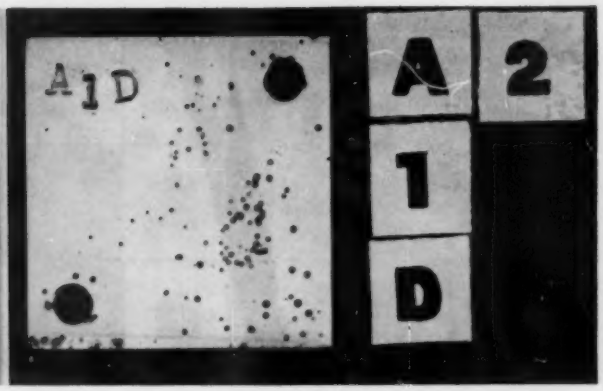


Fig. 8

PANEL EVALUATION

Exposed test panels were evaluated for tarnish resistance by estimating the percent of the total panel area that was tarnished. To do this, a standard panel design was selected, 1½ by 1½ by ⅛ inch (Fig. 5). The tarnished panels were photographed in black and white and high contrast film positives were made using Kodalith Type III High Contrast Film. High contrast film was used to make the tarnish clear cut and to minimize the need for human decision in the later evaluation.

Slides were prepared from the film positives and were projected on a screen that was ruled with a rectangular grid. The lines of the grid were spaced ¼ inch apart. The panel image was projected to a size 25 by 25 inches so that it overlaid 100 vertical and 100 horizontal lines of the grid. Figure 6 illustrates this procedure. In the figure every tenth grid line only is shown. The percentage of the panel surface covered with tarnish was estimated by counting the number of intersections of the grid that fell upon an area of tarnish in the image and dividing by the total number of intersections. The areas immediately surrounding the racking holes were not considered. Also, on the side of the panel containing the stamped code, the area about the stamping was not considered. The dotted lines in Fig. 6 show these areas. With very badly tarnished panels every tenth intersection was considered, with moderately tarnished panels every fifth, and with very slightly tarnished panels every intersection was considered.

The effect of the personality of the evaluator on the method was determined by having six individuals evaluate the same five panels independently of one another. The panels were selected to cover the range of light to heavy tarnish. The results are shown in Table I. The different evaluators agreed rather well, particularly when it is realized that the screen used had a degree of texture that made it difficult to distinguish, in some instances, whether a mark was the image of tarnish or was texture. A more carefully prepared screen would eliminate this variable.

GOLD PLATING STUDY

Three hundred of the standard test panels were prepared using half-hard yellow brass. After being stamped with a 3-symbol code that indicated the plater, the gold thickness, and the exposure site, they were barrel finished to break all edges, to remove surface scratches, and to develop a uniform finish. The finish obtained was 11 microinches, average. The panels were then bright silver plated in a still tank* to a 0.4 mil thickness. Each plated panel was individually wrapped in one layer of tarnish inhibiting paper** and heat sealed in a polyethylene bag.

One set of 30 silver plated test panels was retained at Bendix. The remaining panels were sent, a set of thirty each, to nine plating organizations: Los Alamos Scientific Laboratory; Sandia Corporation in Albuquerque, New Mexico;

*Hanson-Van Winkle-Munning Silver-Lume.
**Silver Saver Paper, Orchard Paper Company.

TABLE I
COMPARISON OF EVALUATORS

Panel	Evaluators						
	A Per Cent	C Per Cent	H Per Cent	M Per Cent	J Per Cent	B Per Cent	Average Per Cent
D2A1	0.02	0.02	0.03	0.01	0.05	0.03	0.035
A2A1	0.2	0.2	0.4	0.4	0.3	0.1	0.27
E2C1	1	2	4	2	4	4	2.8
E1C2	16	14	22	24	22	18	19.3
B1E1	41	52	46	57	65	61	53.7

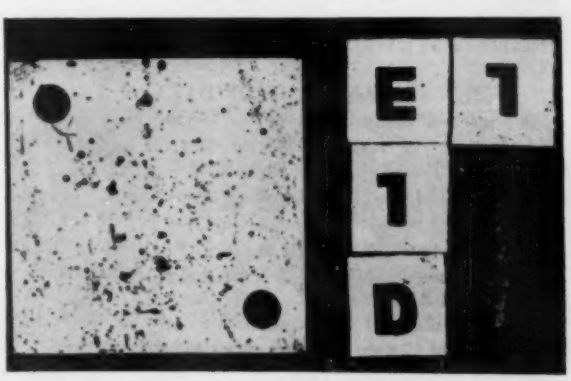


Fig. 9

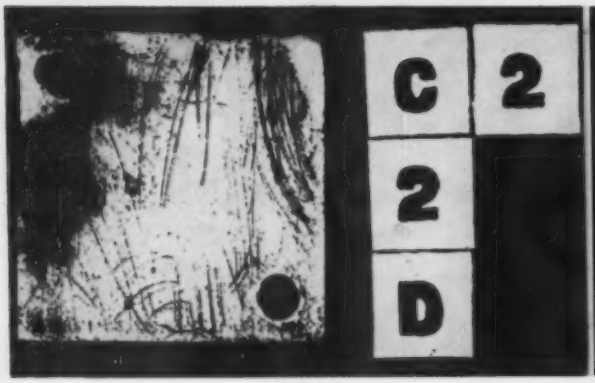


Fig. 10

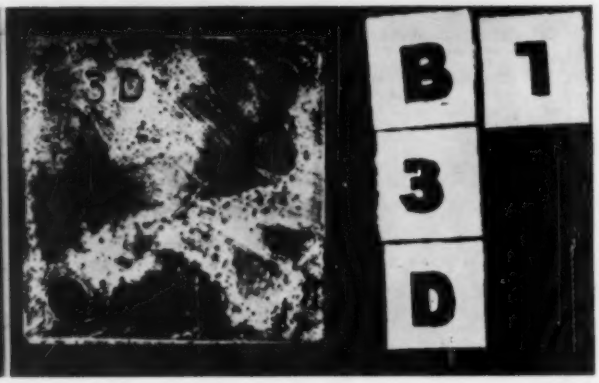


Fig. 11

Sel-Rex Corporation; Technic, Inc.; and five job shops experienced in industrial gold plating.

Each plating organization (including Bendix) was asked to gold plate its 30 panels, ten panels each to nominal thicknesses of 0.05, 0.10 and 0.20 mil. The conventional cyanide gold process and a proprietary cyanide bright gold plating process were used. The panels were then packaged as before and returned to Bendix. The thickness of the gold plating on each side of every panel was measured non-destructively using an X-ray fluorescence technique developed in the Bendix Test Laboratory by C. D. Pettie. In all cases, the range of thicknesses within a thickness group from a given plater was found to be narrow. The arithmetic mean of the thicknesses of the panels in a group was calculated and used in reference to all of the panels in the group.

The 300 gold panels were divided into five groups of 60. Every group contained two panels of each thickness from each plater. These groups were submitted to the accelerated tarnish test, one group each, by Bendix, Los Alamos Scientific Laboratory, Sandia Corporation, Sel-Rex Corporation, and Technic, Inc., each of whom had been supplied with a test chamber. Each exposure site was instructed to arrange its 60 panels in the chamber in a randomly selected order that was unique for that site. After exposure, each exposure site returned the panels to Bendix where they were evaluated. Figures 7, 8, 9, 10 and 11 are typical of the exposed panels.

EXPERIMENTAL RESULTS

Both sides of each panel were evaluated by estimating the per cent of the surface that was tarnished. The values obtained for the duplicate panels tested at each site (two panels of a given thickness from a given plater) were averaged arithmetically. These data and the average gold plating thicknesses are given in Table II.

ANALYSIS OF DATA

A statistical analysis of the data showed that the results obtained by the various exposure sites did not differ significantly. Therefore, the arithmetic average of the tarnish percentages obtained from the sites was calculated (Column 8, Table II) and used to compare platers and thicknesses. The averages are shown graphically in Fig. 12 where the percentage of tarnish is plotted against the average gold plating thickness for each plater.

The percentage of tarnish developed on the panels from platers B and C were so much greater than the others that they were not included in Fig. 12. The nature of the tarnish on these two sets of panels indicated that a different type of failure occurred in the test (see Figs. 10 and 11). Large splotches of tarnish developed, sometimes in a definite scratchy pattern. It was apparent that other factors (poor rinsing, contaminated baths, scratch brushing) not typical of

TABLE II
PER CENT OF TARNISH DEVELOPED AT EACH EXPOSURE SITE
Tarnish, Per Cent

Plater	Thickness, mil	Exposure Site A	B	C	D	E	Average
A	0.05	1	4	2	2	2	2
B	0.05	18	29	48	42	66	41
C	0.15	2	2	3	2	4	3
D	0.07	4	4	1	0.7	3	3
E	0.03	12	26	14	10	15	15
F	0.05	26	8	6	9	16	13
G	0.09	6	10	4	12	5	7
H	0.05	4	3	2	3	4	3
J	0.04	6	6	10	10	4	7
K	0.06	4	6	2	3	5	4
A	0.11	0.2	1	0.2	0.3	0.3	0.4
B	0.09	80	32	76	20	50	52
C	0.21	17	4	11	25	19	15
D	0.11	0.2	0.3	0.2	0.7	0.2	0.3
E	0.08	4	6	1	3	4	4
F	0.11	0.4	0.5	0.6	0.4	0.4	0.4
G	0.09	0.8	0.4	0.6	1	0.8	0.7
H	0.09	0.3	0.9	0.3	0.2	1	0.5
J	0.10	2	0.5	0.4	2	—	1
K	0.10	0.2	0.6	0.2	0.6	2	0.7
A	0.20	0.1	0.2	0.04	0.2	0.1	0.1
B	0.16	60	13	47	48	31	40
C	0.26	6	6	13	1	5	6
D	0.22	0.03	0.08	0.08	0.07	0.1	0.07
E	0.15	0.5	0.1	0.6	3	0.5	0.9
F	0.20	0.04	0.1	0.1	0.03	0.1	0.07
G	0.18	0.05	0.06	0.04	0.1	0.05	0.06
H	0.15	0.2	0.09	0.1	0.3	0.2	0.2
J	0.22	0.2	0.08	0.04	0.05	—	0.09
K	0.19	0.1	0.1	0.2	0.06	0.05	0.1

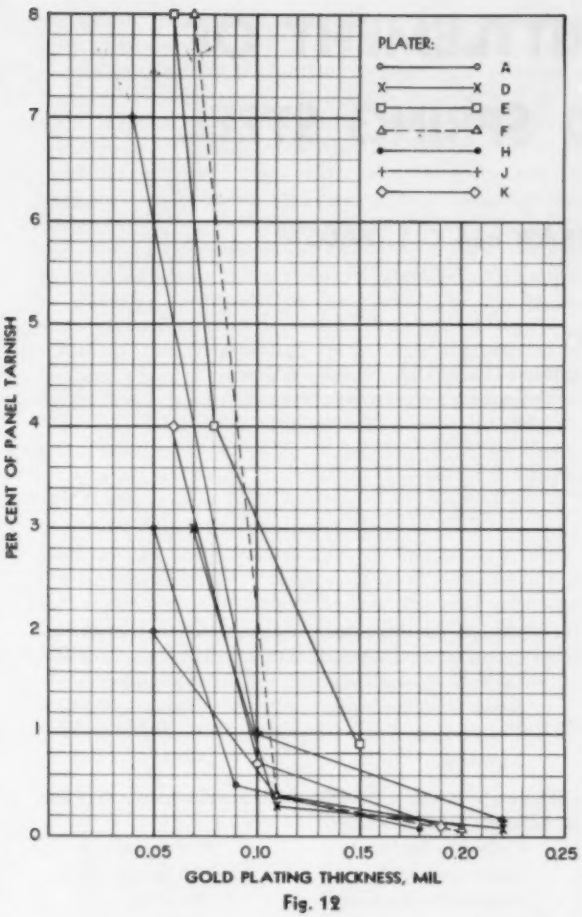


Fig. 12

the rest of the panels were involved, and that the panels were not representative of normal good workmanship. Therefore, the panels from these platers were not considered further.

Figure 12 shows that the porosity of the gold plate decreases rapidly up to around a thickness of 0.1 mil and slowly thereafter. The porosity at 0.1 is significant, and that at 0.2 mil is sufficient to allow a degree of spotting that is unallowable (see Fig. 7). In the thinner deposits, 0.04 to 0.08 mil, the variation in the quality between the platers is quite marked. As the thickness approaches 0.2 mil, the differences tend to disappear.

Since the 0.2 mil gold developed some tarnish, a second set of panels was plated at Bendix to find the minimum thickness that would be effectively pore free; that is, would completely protect the underlying silver in the exposure test. This thickness was found to be about 0.4 mil.

CONCLUSIONS

1. Tarnish Test

The tarnish test will give a measure of the porosity of gold plating over silver. It is a simple test and gives results in a short time. There is no correlation between it and actual exposure, since exposure conditions can vary widely. However, it can be used to compare the porosities of gold plating produced by different platers and to evaluate gold plating processes and process variables.

2. Panel Evaluation

The method of evaluation by projecting the images of the tarnished panels on a grid is free from subjective effects and gives an accurate measure of the tarnish area. The method is somewhat laborious. It is recommended that if this method is used that a group of panels be evaluated that cover the range of tarnish or corrosion to be measured. With these as standards, other panels can be evaluated quickly by visual comparison to the standards.

3. Porosity of Gold Plating

Two of the platers of the gold plated test panels are major suppliers of materials and services for gold plating processes, (Sel-Rex and Technic). It, therefore, is reasonable to assume that the panels prepared by them would represent the best gold plating that can be presently obtained. These panels showed tarnish of the same order of magnitude as those from the other plating sources, excepting platers B and C. It, therefore, can be said that gold plating in the thicknesses commonly employed cannot be expected to be non-porous. When, therefore, it is desired to protect silver from tarnishing with a gold plate, it is necessary to use at least 0.4 mil of gold. Since 0.4 mil of gold plating often is more than enough of this metal to perform the function for which silver plate was originally selected (conductivity, solderability) then, except under the most corrosive conditions, the silver plating can be eliminated and gold plating alone used. If the basis metal is copper or a copper alloy, interestingly enough, the total thickness of the gold usually can be reduced to 0.1 mil.

The gold plating in these tests was produced in the cyanide bath, both conventional and bright. There is some evidence that gold plated from the acid baths based on citric acid is less porous. If this is so, it may then be possible to protect silver plating from tarnishing with a thinner gold plate.

ACKNOWLEDGMENTS

The author wishes to acknowledge the considerable assistance given him in the work reported in this paper by R. K. Asher and also the cooperation of the following organizations:

Burton Silverplating Company, Los Angeles, California
Los Alamos Scientific Laboratory, Los Alamos, New Mexico
M-W Laboratories, Inc., Chicago, Illinois
Philway Manufacturing Company, Ashland, Ohio
Precision Electroplating Company, Chicago, Illinois
Sandia Corporation, Albuquerque, New Mexico
Sel-Rex Corporation, Nutley, New Jersey
Superior Plating Inc., Minneapolis, Minnesota
Technic, Inc., Providence, Rhode Island

REFERENCE

[1]Egan T. F. and A. Mendizza "Creeping Silver Sulfide" Journal of Electrochemical Society **107**, No. 4 353–4 (1960).

William B. Harding received a BS degree in chemical engineering from the University of Kansas in 1947 and an MS from the same institution in 1949. He has been employed by the Kansas City Division of The Bendix Corporation since 1950 working principally with all types of applied finishes. He is currently a Senior Materials Engineer responsible for finishes adhesives and sealants. He is a member of the AES and ASTM committee B-8.

HYDROGEN EMBRITTLEMENT OF CADMIUM PLATED SPRING STEEL

by J. A. GURKLIS, L. D. McGRAW and C. L. FAUST*

ABSTRACT

This article is based upon the results of research sponsored by the U. S. Army Signal Corps, Components Department, to determine optimum processing and plating procedures to minimize hydrogen embrittlement in plated steel springs. The data (1) support the conclusion that cadmium plating does not measurably embrittle spring steel and (2) disclose a safe cleaning and etching procedure. Harmful preplating treatments are described along with an effective baking procedure to relieve embrittlement. The slight sensitivity of spring steel to delayed fracture and fatigue failure, and the efficacy of several test methods for hydrogen embrittlement are established.

INTRODUCTION

MEASUREMENTS OF DUCTILITY have shown that the embrittling effect of hydrogen on steel is sensitive to strain rate. Although fatigue properties have been reported as worsened by plating, the effect of hydrogen is generally conceded to disappear at a very high rate of strain. In consequence of this, ductility measurements are usually made at a low constant rate of strain. Exaggeration of this low rate of strain to zero has disclosed a condition of delayed brittle fracture for high-strength steels. Fracture in sharp-notched specimens can occur at static stresses as low as 100,000 psi when the steels are heat treated to a strength of 270,000 psi and are cathodically charged while under this stress.

In view of the failures reported for spring steel under such vigorous cathodic treatments and under such a variety of stress conditions, a study was made to learn how much blame to place on usual cleaning and plating practice which does not involve drastic cathodic treatments. The study was to involve a variety of stress conditions and strain rates to cover the multiple uses for spring steel.

The program was carried out using feeler-gage SAE 1095 tempered spring steel, hardened to Rockwell C 48-51. Specimens were 0.025 by 0.5 in. and 0.04 by 0.5 in. and had a tensile strength of 233,000 psi. This tempered spring-steel material was selected for use in this study because spring steel of this type is very susceptible to hydrogen embrittlement. Consequently satisfactory procedures developed for minimizing embrittlement or relieving it for the case of this steel should be applicable to less susceptible spring steels.

For the most part, cadmium was plated from cyanide solution. The cyanide plating bath was made up with Cadalyte Salts (E. I. du Pont de Nemours & Co., Inc.) to the following composition:

Cadmium metal	4.0 oz/gal
Total sodium cyanide	15.6 oz/gal
Ratio, NaCN:Cd	3.9:1.0
Caustic soda	2.8 oz/gal
Cadalyte brightener	0.64 oz/gal

*Battelle Memorial Institute, Columbus 1, Ohio.

The cadmium plating usually was carried out under the following operating conditions with soluble cadmium anodes:

Cathode current density	30 amp/sq ft
Anode current density	15 amp/sq ft
Temperature	90–100F
Agitation	None

Where specimens were plated from a fluoborate solution, the following bath was used:

Cadmium fluoborate	32.2 oz/gal
Cadmium metal	12.6 oz/gal
Ammonium fluoborate	8.0 oz/gal
Licorice	0.134 oz/gal

It was operated with soluble anodes under the following conditions:

*p*H	3.0–3.5
Temperature	70–80F
Cathode current density	45 amp/sq ft
Anode current density	15–20 amp/sq ft

Preplating procedures varied and are described in the text.

EVALUATION OF TEST METHODS

Introduction

An anodic etch was used as a control method of preparing steel for plating. When an anodic etch in sulfuric acid was followed by rapid and complete rinsing and drying, there was no evidence of embrittlement according to the results of tensile tests, compression bending, or bending around a mandrel at constant rate in an apparatus designed after Zapffe.[1] These results were expected. However, unexpected results followed from similar studies on cadmium-plated spring steel. Therefore, the suitability of various test methods as indications of hydrogen embrittlement had to be evaluated.

Constant-Rate Bend Test is Unreliable for Plated Specimens

Steel which was cadmium plated after preparation by anodic etching in sulfuric acid showed no evidence of embrittlement except in terms of a shorter bend made around a ¼-inch diameter mandrel at a constant rate of 4.4 degrees

per second. During the course of the work, the constant-rate bend test became suspect as to its reliability for measuring the relative ductility of plated spring steel. The observation that specimens plated only on one side broke at high or low bend angles, depending on whether the plated side was in compression or tension, indicated that the presence of the cadmium plate itself might affect the angle of fracture. To evaluate this premise, some spring-steel specimens were coated by vacuum metallizing with 0.0003 to 0.0005 inch of cadmium. In the constant-rate bend tests, these specimens exhibited an apparent loss of ductility, and behaved similarly to specimens electroplated on one side only, i.e., the fracture angle values for plated or coated side in tension were about 1.6 to 2.0 times higher than for those in compression. A further indication that the ductility as measured by the constant-rate bend test is influenced by the presence of the plate was obtained by stripping the plate from cadmium-plated specimens by anodic treatment in sodium cyanide solution (45 g/l, 75–80F). The stripped specimens behaved in a ductile manner, indicating that they probably had never been embrittled. The anomalous results of the constant-rate bend test for electroplated steel are indicated in Fig. 1. Organic coatings, layers of pressure-sensitive masking tape, solder, etc., on steel similarly lowered the bend angle indicating that coatings per se interfered with the bend test. When a lower bend rate (0.44 degree per second) was used to observe the influence of strain rate on angle of fracture, the apparent brittleness of plated steel was exaggerated.

When the effect of pickling for one minute in 10 per cent hydrochloric acid was studied, all the test methods indicated embrittlement. The reduction in area was cut in half which was highly significant and served as a sort of calibration for the two qualitative bend tests. The constant-rate bend test was reliable in the absence of plate on the steel.

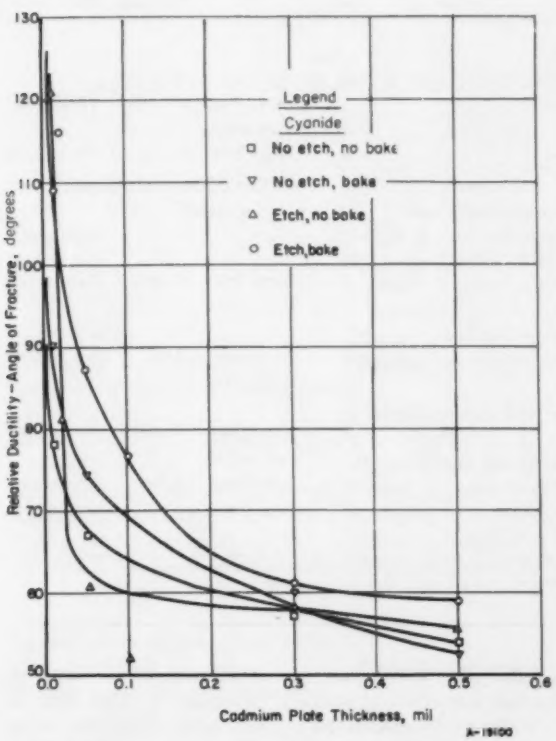


Fig. 1. Apparent effects of anodic acid etching, baking, and plate thickness on the relative ductility of spring steel plated from a cadmium-cyanide bath as measured by the constant-rate bend test. [The bend-angle values represent an average of eight specimens per point. In the unplated as-received condition, the spring steel (0.041 by 0.5 in.) broke at an average angle of 149 degrees.]

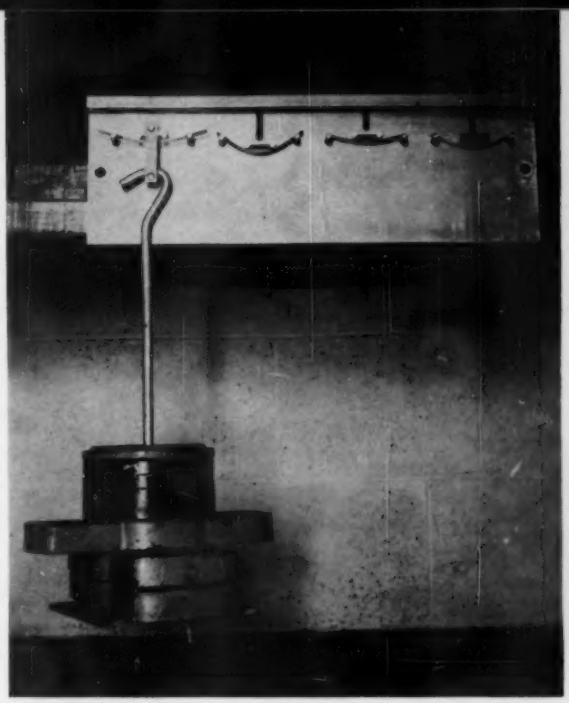


Fig. 2. Apparatus for studying delayed-type failure in spring steel by means of a stress-rupture test.

The pickled steel was cadmium plated without any decrease in ductility beyond that suffered from pickling, except in the case of the constant-rate bend test which erroneously indicated additional embrittlement.

Low Sensitivity of Spring Steel to Delayed Fracture

Exploratory study using the above test methods had given anodic etching and cadmium plating a clean slate as regards embrittlement of the spring steel under study, but showed that even a short acid dip was dangerous. Thinking that a test involving a delayed fracture might be more sensitive and detect embrittlement in cadmium-plated spring steel, a stress-rupture apparatus was devised (Fig. 2) for stressing flat steel springs with a constant load or to a constant deflection. Stresses were calculated from the measured deflection or from weights applied to specimens which were not stressed beyond their yield point.

Delayed fractures were not observed for anodically etched and plated specimens using loadings up to the yield point of the steel as shown in Table I. Even steel pickled for one minute in 10 per cent hydrochloric acid did not exhibit delayed fracture, i.e., its stress-rupture strength was not lowered. After a 10-minute cathodic pickle in sulfuric acid at 10-asf current density, the steel did not show delayed failures up to 195,000 psi. However, after a 20-hour cathodic pickle at 30 asf it did consistently fracture in a delayed manner for loads over about 117,000 psi. A vigorous pickling treatment was also required to obtain delayed fracture of spring steel bent almost to the breaking point in compression between the jaws of a vise.

This compression test [or vise-type bend test[2]] was a

TABLE I

EFFECTS OF ETCHING AND PICKLING ON THE DUCTILITY OF CADMIUM-PLATED SPRING STEEL AS SHOWN BY STRESS-RUPTURE TESTS[a, b]

Specimen History Before Plating[c]	Plate Thickness, inch	Elapsed Time From Plating to Start of Test	Type Loading: Constant Load	Type Loading: Constant Deflection	Type Loading: Vise Test, Constant Deflection	Stress,[d] 1000 psi	Duration of Test	Results
Mild cathodic pickling at 10 amp/sq ft for 10 min in sulfuric acid solution (800 g/l)	0.0003	10 min	√	—	—	144	6 days	No failure
	0.0003	20 min	—	√	—	156	6 days	No failure
	0.0003	25 min	—	√	—	117	6 days	No failure
	0.0003	30 min	—	√	—	195	6 days	No failure
Heavy cathodic pickling[e] at 30 amp/sq ft for 19.5 hr in sulfuric acid solution (800 g/l)	0.0005	30 min	√	—	—	144	10 min	Failure
	0.0005	50 min	√	—	—	125	2 min	Failure
	0.0005	60 min	√	—	—	125	14 min	Failure
	0.0005	35 min	—	√	—	156	2 min	Failure
	0.0005	70 min	—	√	—	117	6 min	Failure
	0.0005	80 min	√	—	—	107	3 days	No failure
	0.0005	95 min	—	√	—	78	3 days	No failure
Heavy cathodic pickling at 30 amp/sq ft for 19.5 hr, and followed 2 hr later by anodic treatment in sulfuric acid solution (800 g/l) at 250 amp/sq ft for 5 min	0.0005	30 min	—	√	—	156	24 min	Failure
	0.0005	90 min	—	√	—	117	10 days	No failure
Pickled in 10% (by wt) hydrochloric acid solution for 1 min and baked for 9 hr at 400F after plating	0.0003	4 days	—	—	√	Near fracture stress	55 min	Failure
	0.0003	5 days	—	—	√	Near fracture stress	14 hr	No failure
Pickled in 10% (by wt) hydrochloric acid solution for 1 min and baked for 1.5 hr at 400F after plating	0.0003	4 days	—	—	√	Near fracture stress	15 min	Failure
Pickled in 10% (by wt) hydrochloric acid solution for 1 min, but not plated	Not plated	1 hr	—	—	√	Near fracture stress	1 hr	No failure
Anodically etched at 100 amp/sq ft for 1 min in sulfuric acid solution (800 g/l)	0.0003	1 day	—	—	√	Near fracture stress	3 days	No failure
(also see footnote b)	0.0003	13 hr	—	—	√	Near fracture stress	12 hr	No failure

(a) The spring steel was 0.041 by 0.5 inch.
(b) The spring-steel specimens were plated in a cyanide-type bath, except for the specimen described by the last entry in the table which was plated in a fluoborate-type bath.
(c) Before receiving the treatment indicated in this column, the test specimens had been solvent degreased and then anodically cleaned in Anodex solution.
(d) The stresses were calculated from the load or deflection. With the vise-type constant-deflection tests the stress values were not known.
(e) The cadmium plates put on the heavily cathodically pickled specimens were blistered.

reproducible measure of ductility for plated or unplated steel. In the vise-type bend test, the relative ductilities of unplated and plated spring steel were determined by measuring (in hundredths of an inch) the vise openings at fracture of specimens bent between the vise jaws. The spring-steel specimens were placed between the jaws of a vise and then the vise jaws were gradually closed until the specimen broke. Preliminary experiments with specimen lengths of 3.0, 2.5, 2.0, and 1.5 inches showed that the best size for use was the 1.5-inch length. The vise-closing time from start of the bend to fracture was about 15 seconds; increasing this time interval to about 25–30 seconds did not noticeably change the value of the vise opening at fracture. The reproducibility of results was good for bend-to-failure tests. Hence the vise and tension tests were used extensively.

Stress-rupture strength was so insensitive to hydrogen that delayed fracture tests with the vise or the stress-rupture apparatus were not practical for study of relief of severe or

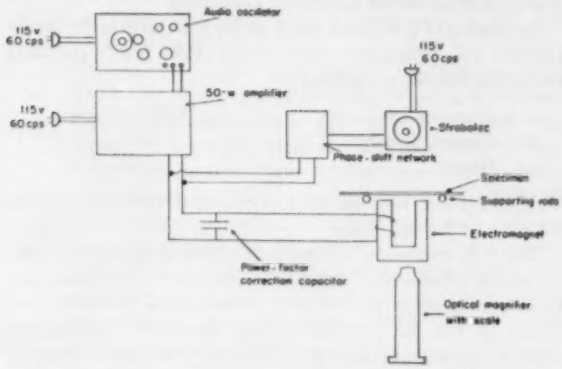


Fig. 3. Block diagram showing the essential details of the electronic system for the electromagnetic fatigue-testing apparatus.

mild embrittlement. The sensitivity was not increased by notches producing over twofold increase in stress (Table II).

FATIGUE STRENGTH NOT SENSITIVE TO HYDROGEN

Introduction

Chromium plating has been observed to lower the fatigue strength of high-strength aircraft steel. It has not been fully established whether this is due to a notch effect related to the cracks in chromium plate or due to hydrogen embrittlement. Although current theory denies a lowering of fatigue strength by hydrogen, pickled and cadmium-plated steel was tested in fatigue for checking this point.

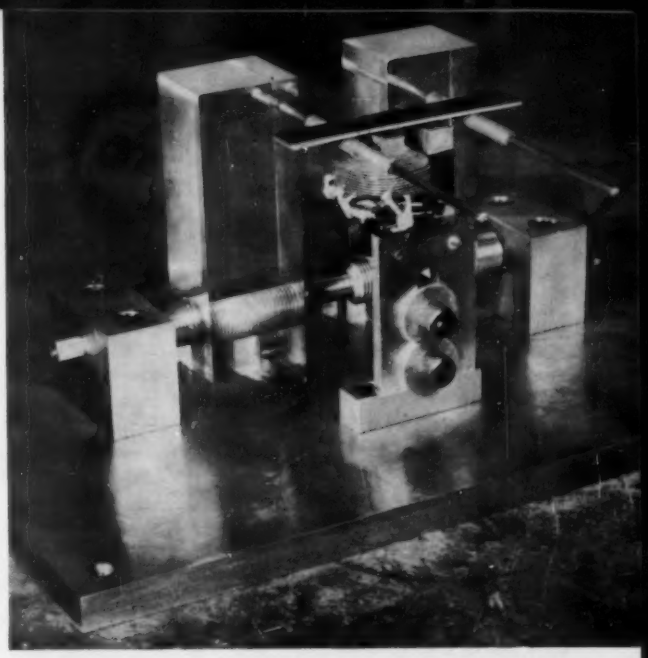


Fig. 4. Close-up view of the electromagnetic fatigue-testing apparatus.

Fatigue Test

Flat 0.5-inch-wide, 0.025- and 0.040-inch-thick specimens

TABLE II

ATTEMPTS TO SHOW DELAYED-TYPE FAILURE IN CADMIUM-PLATED SPRING STEEL[a, b]

Description of Specimen Before Plating	History of Plated Specimens	Type Loading: Constant Load	Type Loading: Constant Deflection	Stress,[c] psi	Stress Factor	Duration of Test, days	Results and/or Remarks
Unnotched	Plated 1 year before test	√	—	163,000	1	50	No failure
Unnotched	Plated and baked (2 hours, 525F) 1 year prior to testing	—	√	Yielded	1	60	No failure
Unnotched	Plated 1 year before test	—	√	156,000	1	60	No failure
Unnotched	Plated 1 year before test	—	√	Yielded	1	60	No failure
Notched with scriber across specimen faces[d]	Plated 1 hour before test	√	—	163,000	Unknown	3	No failure
Notched with scriber across specimen faces[d]	Plated 1 hour before test	—	√	156,000	Unknown	3	No failure
Notched at both edges of specimen[e]	Plated ½ hour before test	√	—	163,000	2.2[e]	38	No failure
Notched at both edges of specimen[e]	Plated ½ hour before test	—	√	156,000	2.2[e]	38	No failure
Notched at both edges of specimen[e]	Plated ½ hour before test	—	√	Yielded	2.2[e]	38	No failure
Notched at both edges of specimen[e]	Plated ½ hour before test	—	√	195,000	2.2[e]	38	No failure, may have yielded.
Ground across specimen faces with 80-X grit belt[f]	Plated 1 hour before test	—	√	Yielded	Unknown	3	No failure
Ground across specimen faces with 80-X grit belt[f]	Plated 1 hour before test	—	√	156,000	Unknown	3	No failure

(a) The flat spring-steel specimens, having an ultimate strength of 247,000 psi in the unplated condition, were loaded in the stress-rupture test apparatus shown in Figure 2.
(b) The spring-steel specimens were plated in a cadmium-cyanide bath. The plate thickness was 0.0003 inch.
(c) The stresses were calculated from the load or deflection. Stresses are not reported for the specimens that yielded under the measured deflection because they could not be calculated.
(d) These specimens were notched across both faces using a scriber with a tungsten-carbide point (Point No. 778, Style 1, Brown and Sharpe Mfg. Co., Providence, Rhode Island).
(e) A notch (0.03-inch radius and 0.05-inch depth) was made in both edges of the specimen. This type of notch was calculated to produce a 2.2-fold increase in stress at the notch. (Reference: R. E. Peterson, "Stress Concentration Design Factors", John Wiley and Sons, New York, N. Y., 1953, p. 43.)
(f) The specimens were ground across both faces using a grinding wheel with a 80-X grit belt (Behr Manning Co., Troy, New York). Such unplated ground specimens broke at an average angle of 61 degrees in the constant-rate bend test compared with 149 degrees for control specimens in the unplated as-received condition.

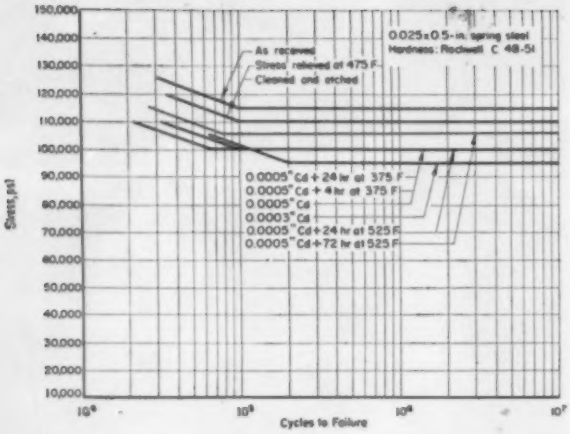

0.025×0.5-in. spring steel
Hardness: Rockwell C 48-51
As received
Stress relieved at 475 F
Cleaned and etched
0.0005" Cd + 24 hr at 375 F
0.0005" Cd + 4 hr at 375 F
0.0005" Cd
0.0003" Cd
0.0005" Cd + 24 hr at 525 F
0.0005" Cd + 72 hr at 525 F
Stress, psi
Cycles to Failure

Fig. 5. Comparison of S-N curves for as-received, electroprocessed, and heat-treated spring steel.

were cut to lengths (2.62 and 3.32 inches, respectively) such that the natural frequency of their vibration, when supported as beams, was 800 cycles per second. They were supported over an electromagnet which could be tuned to half this frequency and could flex the specimens over any desired amplitude. A block diagram of the electro-mechanical system, and a close-up photograph of the electromagnetic fatigue-testing unit are shown in Figs. 3 and 4. About 3½ hours produced a 10-million-cycle run out, and stress was calculated from the deflection of the vibrating specimens. The deflection could be measured using an optical magnifier when the panel was optically frozen in position of maximum deflection with a stroboscopic light adjusted to the same frequency.

Fatigue Results for Cadmium Plating

Stress relief at 475F for one hour had practically no effect on the endurance limit of 0.025-inch-thick spring steel, nor did cleaning and anodic-etching processes. These results and the results of similar endurance tests on cleaned, anodically etched, and plated steel are graphically shown by S-N curves in Fig. 5 for 0.025-inch-thick steel. Cadmium plating reduced the endurance limit of 0.025-inch-thick spring steel only to the extent of about 15 to 20 per cent. Within the plate-thickness range studied (0.0003 to 0.0005 inch), the reduction was practically independent of plate thickness. Heat treatment of the plated steel at 375F for four and 24 hours, or at 525F for 24 and 72 hours, did not restore the fatigue strength of the plated spring steel.

Cadmium plating did not lower the fatigue strength of the 0.040-inch-thick spring steel. However, the fatigue strength of this thicker steel was already lower in the as-received condition than the fatigue strength of the cadmium-plated 0.025-inch-thick steel. The heavier gage material was the best commercially available but, because of its surface quality, did not permit detection of fatigue damage due to cadmium plating. Hence, baking treatments were not applied.

The specimens used in the above tests involving fatigue studies on plated steel were not stress relieved because stress relief had been shown to offer no improvement in the fatigue strength of the as-received material. The specimens were, however, cleaned and anodically etched by the procedure which had been previously demonstrated not to lower fatigue strength.

Fatigue Results for Cathodic Charging

Specimens of 0.025-inch-thick spring steel were cathodically charged with hydrogen in sulfuric acid (800 g H_2SO_4 per liter) under the following conditions:

Temperature	80F
Current density	5 asf
Time	2.5 minutes

This treatment resulted in a substantial reduction of the ductility of the specimens.

The S-N curves for cathodically charged spring-steel material which had either been stored in air at room temperature or in a mixture of dry ice and acetone prior to testing are shown in Fig. 6. Specimens were stored in the freezing mixture to prevent escape of hydrogen. The fatigue strength of the spring steel was slightly lowered by cathodic charging with hydrogen. The lowering was no greater in the case of the specimens charged and then stored at room temperature than the lowering caused by stress relief or by cleaning and etching. This indicates that the damage by hydrogen is negligible. The endurance limit was about 5000 psi lower for the specimens stored in the freezing mixture than for those stored at room temperature. These results indicate that no more than 30 per cent of the slight loss of fatigue strength caused by plating can be attributed to hydrogen damage. In conclusion, hydrogen embrittlement causes only a small loss of dynamic fatigue strength.

RESULTS

Cadmium Plating and Hydrogen Embrittlement

The above discussion of test methods clarifies several misconceptions regarding the utility of several test procedures for the case of spring steel. In so doing, it also points to the fact that SAE 1095 spring steel is insensitive to certain damaging features (delayed fracture, and loss of fatigue strength) sometimes attributed to hydrogen contamination from electroprocessing. Data are now presented to show that plating of cadmium itself does not measurably embrittle SAE 1095 spring steel hardened to Rockwell C 48-51.

The effects of plating and processing variables (anodic etch, HCl pickle, aging, and baking) on the ductility of cadmium-plated spring steel, as measured by tension tests, are summarized in Table III. The most noticeable changes with different processing techniques were in the reduction-of-area, percentage-of-elongation, and fracture-stress values. The results of these studies are summarized below:

(1) Anodic etching by itself, or anodic etching followed by cadmium plating, did not change the ductility of the spring steel.

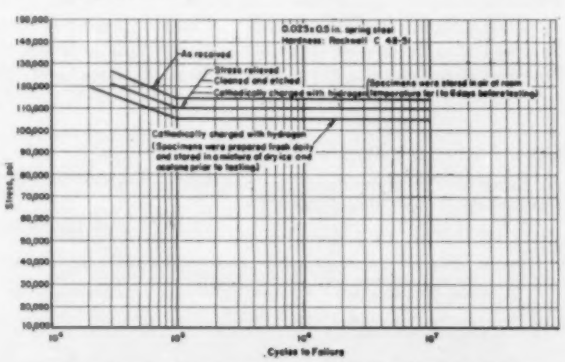

0.025×0.5 in. spring steel
Hardness: Rockwell C 48-51
As received
Stress relieved
Cleaned and etched
Cathodically charged with hydrogen (Specimens were stored in air at room temperature for 1 to 6 days before testing)
Cathodically charged with hydrogen (Specimens were prepared fresh daily and stored in a mixture of dry ice and acetone prior to testing)
Stress, psi
Cycles to Failure

Fig. 6. Effect of cathodic charging with hydrogen on the fatigue strength of spring steel.

(2) Aging and baking of cadmium-plated spring steel that had been anodically etched before plating did not affect the ductility.

(3) The use of a short (one minute) hydrochloric acid pickle (10 per cent by weight) before plating embrittled the spring steel. This was encountered with specimens plated from either the cyanide- or fluoborate-type baths. Aging of these specimens for only a few hours resulted in some recovery of ductility.

(4) Processing and plating of spring steel only slightly changed its tensile or yield strength. For this reason, these values are not indicative of embrittlement.

These findings as determined by the tension tests are in agreement with the results of other reliable tests, i.e., the vise-type bend test and the less sensitive stress-rupture tests. Since the results of using the vise-type bend test agreed with the results obtained with the tension test and because the vise-type bend test was simpler and more economical of time and money to use, it was utilized for evaluating treatments for relief of embrittlement of plated spring steel that had been deliberately pickled to produce some embrittlement.

Preplating Treatments and Hydrogen Embrittlement

The effects of cleaning and plating procedures and of aging and baking on the ductility of cadmium-plated spring steel as shown by vise-type bend tests are summarized below:

(1) Anodic etching followed by cadmium plating from either a cyanide or fluoborate bath did not embrittle spring steel. Aging and baking did not affect the ductility of specimens processed in this manner.

(2) Slight variations were observed in the ductility of spring steel anodically etched and then plated from two bright cyanide-cadmium baths differing in performance because of differences in age. Variations in ductility of the same order of magnitude were observed using steels from different heats. Aging and baking did not affect the ductility of specimens processed in this manner.

(3) The use of a short (one minute) or prolonged hydrochloric acid pickle (10 per cent HCl by weight) embrittled spring steel. Subsequent plating from either the cyanide or fluoborate bath of the pickled spring steel did not significantly change the ductility of the pickled spring steel for plate thicknesses in the range of 0.00005 to 0.001 inch.

(4) Complete recovery of ductility of unplated spring steel that had been pickled for as long as 20 minutes in hydrochloric acid solution (10 per cent HCl by weight) was achieved by aging at room temperature (70–80F) within 24 hours. The rate of recovery was greatest during the period immediately following pickling, becoming negligible after 24 hours when recovery was complete.

(5) Aging at room temperature (70–80F) of plated spring steel embrittled by prior pickling resulted in a slight increase in ductility during the first 24 hours after pickling and plating. After the 24-hour aging period there was but little change in the ductility for periods ranging up to two weeks, indicating retention of most of the hydrogen. This was true for plate thicknesses in the range of 0.00005 to 0.001 inch.

(6) Baking at 400F of plated spring steel (0.0003-inch plate thickness) embrittled by prior pickling required 24 hours to insure relief of embrittlement. No significant effect of delaying the baking treatment was observed on the relief of embrittlement of plated spring steel.

The results given above constitute a summary of the experimental work reported in Tables IV, V, and VI. The observations that anodic etching followed by plating does not cause embrittlement, and that aging and baking do not influence the ductility of anodically etched and plated spring steel, are apparent from the data of Table IV (Part A) and Table IV (Part B). Table V (Part B) also shows the slight, and approximately equal, variations in ductility observed for different heats of steel and for plating from cyanide baths of different age. It should be noted that the two independent variables (steel and plating bath) are the only significant variables, since plate thickness and aging and baking of the anodically etched and plated spring steel had no influence on the results.

Table IV (Part B) and Table V (Part A) show the embrittling effect of using a mild or prolonged acid pickle before cadmium plating. The data of Table V (Part A) also prove that this embrittling effect is of a greater order of magnitude than the variations in ductility observed for different heats of steel, for plating from different-age baths, and for different thicknesses of plate. The slight recovery of ductility of these embrittled specimens with aging is also shown.

Since baking restored the ductility of the pickled and plated steels, the relief of embrittlement by baking is reported separately in Table VI for one heat of steel. Some earlier results covering baking times up to 10 hours are also included in Table IV (Part B). Here plate thickness was not varied. However, it appears justified to predict that even thin plate (0.00005-inch thickness) will retard restoration of ductility by baking as it does in the case of aging.

CONCLUSIONS

It is concluded from these results that the use of anodic etch followed by cadmium plating is a safe procedure to employ in the processing of SAE 1095 spring steel to minimize embrittlement.

It might be further concluded that cadmium plating of itself does not contribute measurably to the embrittlement of steel springs. This conclusion is based on a combination of observations which give quantitative significance to measurements of relative ductility. They are: (1) that the effect of an anodic etch followed by plating could not be detected from reduction in area of tensile specimens or from the vise-type bend test, (2) that plating did not measurably alter the ductility of spring steel already embrittled by pickling according to the vise-type bend test; and (3) that pickling did measurably reduce ductility according to the vise-type bend test and reduction in area of tensile specimens. These observations alone show that hydrogen embrittlement caused by plating spring steel cannot be detected by the tests; but they do not prove that commercial plating practices do not cause dangerous embrittlement. The latter conclusion is based on the fact that no embrittlement by plating alone has been observed in this research to be greater in magnitude than the normal variations in ductility found among heats of commercial spring steel. This attaches a quantitative significance to the tests of relative ductility, and proves that cadmium plating cannot be responsible for abrupt changes in ductility which are greater than variations in the properties of spring steel.

Other conclusions regarding the relief of embrittlement of plated steel springs are that aging for short periods (up to

TABLE III

EFFECTS OF PLATING AND PROCESSING VARIABLES ON THE DUCTILITY OF CADMIUM-PLATED SPRING STEEL AS MEASURED BY TENSION TESTS[a, b]

Specimen 12170-	Specimen History: Type Plating Bath	Basis-Metal Preparation	Plate Thickness, mil	Baking at 400F, hours	Time Interval Between Plating and Baking, hours	Aging Time After Plating or Baking, hours	Reduction in Area: Individual, per cent	Reduction in Area: Average, per cent	Elongation: Individual, per cent	Elongation: Average, per cent	Tensile Strength, 1000 psi	Yield Strength,[c] 1000 psi	Fracture Stress, 1000 psi
37–5 to 7	Not plated	None	None	None	Not baked	None	—	13.3	—	7.5	231 (avg)	211 (avg)	267 (avg)
41–1 to 4	Cyanide	Anodic etch	0.3	None	Not baked	168	—	13.4	—	7.2	232 (avg)	211 (avg)	268 (avg)
37–1 to 4	Cyanide	Anodic etch	0.3	3.5	24	192	—	13.6	—	7.0	230 (avg)	209[e]	266 (avg)
39–1 to 4	Cyanide	Anodic etch	0.3	5.0	1	168	—	14.7	—	7.8	230 (avg)	209[e]	269 (avg)
40–1 to 4	Cyanide	Anodic etch	0.5	13.5	0.8	160	—	13.7	—	7.4	232 (avg)	213 (avg)	269 (avg)
59–1	Cyanide	Anodic etch	0.3	None	Not baked	0.5	13.6		8.5		231	N.D.[f]	268
–2	Cyanide	Anodic etch	0.3	None	Not baked	0.6	13.5	13.5	8.1	8.1	232	208	268
–3	Cyanide	Anodic etch	0.3	None	Not baked	0.8	13.5		8.3		232	N.D.	268
–4	Cyanide	Anodic etch	0.3	None	Not baked	1.0	13.4		7.4		232	N.D.	267
55–1	Cyanide	HCl pickle[d]	0.3	None	Not baked	1.0	6.0		3.8		232	N.D.	247
–2	Cyanide	HCl pickle[d]	0.3	None	Not baked	1.2	6.6	6.3	4.0	3.9	232	214	248
–3	Cyanide	HCl pickle[d]	0.3	None	Not baked	2.8	7.3		5.0		232	215	251
–4	Cyanide	HCl pickle[d]	0.3	None	Not baked	3.0	7.4	7.4	5.8	5.4	233	210	252
56–1	Fluoborate	HCl pickle[d]	0.3	None	Not baked	0.8	7.4		4.7		232	213	250
–2	Fluoborate	HCl pickle[d]	0.3	None	Not baked	1.0	6.9	7.2	4.0	4.4	233	213	250
–3	Fluoborate	HCl pickle[d]	0.3	None	Not baked	2.8	8.6		6.7		233	206	255
–4	Fluoborate	HCl pickle[d]	0.3	None	Not baked	3.0	8.6	8.6	6.0	6.4	233	208	255
60–1	Not plated	Anodic etch	None	None	Not baked	1.3[g]	14.6		8.2		232	N.D.	271
–2	Not plated	Anodic etch	None	None	Not baked	1.5[g]	13.3	14.0	7.6	8.0	232	204	267
–3	Not plated	Anodic etch	None	None	Not baked	1.8[g]	13.8		8.4		230	N.D.	267
–4	Not plated	Anodic etch	None	None	Not baked	2.0[g]	14.2		7.7		230	N.D.	268

(a) The spring steel was 0.040 by 0.5 inch. Specimens for the tension tests had a reduced-section width of 0.45 ± 0.010 inch for a 2.0-inch gage length, the over-all specimen length was 12 inches.
(b) A Baldwin-Southwark (Philadelphia, Pa.) tensile machine was used for these tests. The rate of loading was 1000 lb/min, which was equivalent to a head speed of approximately 0.035 in./min.
(c) The yield strength was measured at 0.2 per cent offset.
(d) The specimens were pickled in 10 per cent by weight hydrochloric acid solution (80–85F) for 1 min prior to plating. This procedure was used deliberately to introduce some hydrogen into the steel.
(e) Only 1 specimen was tested.
(f) N.D. indicates that the value for the particular entry was not determined.
(g) These values indicate time between anodic etch and testing.

TABLE IV

EFFECTS OF AGING AND BAKING ON THE RELATIVE DUCTILITY OF CADMIUM-PLATED SPRING STEEL AS MEASURED BY VISE-TYPE BEND TESTS[a, b]

	Not Baked: Aged Up to 6 Hours: Cyanide			Fluoborate		Aged More Than 6 Hours: Cyanide					Fluoborate		Baked at 400F: 1.5-3.0 Hours: Cyanide	Fluoborate	4.3-5.5 Hours: Cyanide	8.5-10.0 Hours: Cyanide	Fluoborate
Part A: Anodically Etched and Plated																	
Time Interval Between Plating and Baking, hours	—	—	—	—	—	—	—	—	—	—	—	—	24	1	—	24	—
Aging Time After Plating and Baking	15–20 min	2 hr	5.5 hr	15–20 min	5 hr	13 hr	20 hr	3 days	7 days	14 days	20 days	12 hr	12 days	7 days	6 days	—	13 days	—
Number of Samples	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	—	1	—
Number of Bend Tests	7	7	7	14	7	7	7	7	14	7	7	7	7	7	7	—	7	—
Average Vise Opening at Fracture, inches	0.95	0.95	0.95	0.94	0.93	0.94	0.94	0.92	0.93	0.96	0.94	0.93	0.92	0.95	0.95	—	0.93	—
Part B: Acid Pickled[c] and Plated																	
Time Interval Between Plating and Baking, hours	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1
Aging Time After Plating and Baking	15–30 min	1 hr	6 hr	15–20 min	—	19–20 hr	2 days	—	—	—	—	6 days	12 days	30 min–12 days	1–12 days	30 min–12 days	1–12 days	2–6 days
Number of Samples	3	1	1	1	—	3	1	—	—	—	—	1	1	6	3	3	6	2
Number of Bend Tests	21	7	7	7	—	21	7	—	—	—	—	7	7	42	21	21	42	14
Average Vise Opening at Fracture, inches	1.14	1.08	1.06	1.09	—	1.03	1.04	—	—	—	—	1.00	1.02	1.07	1.07	1.06	1.04	1.04

(a) The vise-test specimens were 1.5 inches long.
(b) The spring steel was 0.040 by 0.5 inch. In the unplated as-received condition the spring steel broke at an average vise opening of 0.94 inch. The thickness of the cadmium plate was 0.0003 inch.
(c) Acid pickling of the specimens prior to plating was carried out by dipping the specimens in 10 per cent by weight hydrochloric acid solution at 80–85F for 1 minute. (The temperature of the pickling solution is important; with lower temperature of 65–70F, the pickling action is slower and there is less embrittlement induced.)

TABLE V

EFFECTS OF ACID PICKLING AND OF OTHER PLATING AND PROCESSING VARIABLES ON THE RELATIVE DUCTILITY OF CADMIUM-PLATED SPRING STEEL AS MEASURED BY VISE-TYPE BEND TESTS

	Spring-Steel Coil No. 1,[a] Cyanide-Cadmium Plating Bath		Spring-Steel Coil No. 2,[a] Cyanide-Cadmium Plating Bath				
	Bath No. 1[b]	Bath No. 2[b]	Bath No. 1[b]				Bath No. 2[b]
Part A: Acid Pickled[c] and Plated							
Pickling Time, minutes	1.0	—	0.25	1.0	10	20	20
Number of Samples	6	—	8	20	8	8	4
Number of Bend Tests	42	—	56	140	56	56	28
Vise Opening at Fracture,[d] inches							
Average Value After Aging 1 or More Days	1.05	—	1.02	1.04	1.17	1.19	1.20
Average Value After Aging 1 Hour or Less	1.08	—	1.03	1.08	1.19	1.23	1.23
Part B: Anodically Etched[e] and Plated							
Number of Samples	24	8	—	35	—	—	28
Number of Bend Tests	168	56	—	245	—	—	196
Average Vise Opening at Fracture,[f] inch	0.94	0.90	—	0.97	—	—	0.93

(a) The coils were from different heats of steel. The spring steel was 0.040 by 0.5 inch. In the unplated as-received condition the spring steel broke at an average vise opening of 0.94 inch for Coil No. 1 and 0.95 inch for Coil No. 2.
(b) Two cyanide baths of the same original composition were used, the difference being in the age and usage of the baths; Bath No. 1 was in use for 5 to 10 months, Bath No. 2 was in use less than 2 weeks.
(c) Acid pickling of the specimens prior to plating was carried out by dipping them in 10 per cent by weight hydrochloric acid solution at 78–80F.
(d) The average value of the vise opening at fracture for plated specimens embrittled by prior acid pickling was independent of (1) aging (after 1 day) and (2) plate thickness (0.00005 to 0.001 inch). See Table VI for relief of embrittlement by baking.
(e) The specimens were anodically etched at 100 amp/sq ft for 1 minute in sulfuric acid solution (800 g/l) at 75–80F prior to plating.
(f) The average value of the vise opening at fracture was independent of (1) aging (0 to 1 month), (2) baking (2 to 24 hours at 400F), and (3) plate thickness (0.00005 to 0.001 inch).

TABLE VI

RECOVERY OF DUCTILITY BY BAKING AT 400F OF CADMIUM-PLATED SPRING STEEL THAT HAD BEEN EMBRITTLED BY PROLONGED ACID PICKLING[a, b, c]

Baking Time, hours	Average Vise Opening at Fracture, inches, After Indicated Processing				
	18-Hour Delay in Baking		Baked Within 1 Hour After Plating		
	10-Min HCl Dip	20-Min HCl Dip	10-Min HCl Dip	20-Min HCl Dip	20-Min HCl Dip[d]
0 (not baked)	1.18	1.22	1.18	1.23	1.23
3	—	—	1.15	1.12	—
4	1.13	—	—	—	—
6	—	1.09	1.12	1.05	—
7	—	—	—	—	0.94
9	—	—	1.05	0.99	—
14	1.06	1.01	—	—	—
20	—	—	1.04	0.98	—
24	—	—	1.00	0.99	0.92
24	—	—	0.97	0.95	—

(a) The spring steel was 0.040 by 0.5 inch. In the unplated as-received condition the spring steel broke at an average vise opening of 0.94 inch.
(b) The cadmium-plate thickness was 0.0003 inch. The specimens were tested in the vise-bend test within 24 hours after baking.
(c) Prolonged acid pickling of the specimens prior to plating was carried out by dipping them in 10 per cent by weight hydrochloric acid solution at 78–80F.
(d) The values listed in this column are for specimens plated in cyanide Bath No. 2 [See Table V, footnote (b)]; the remainder of the values are for specimens plated in Bath No. 1.

two weeks) does not restore ductility, and that baking at 400F for 24 hours is required to insure recovery of ductility. It is not critical whether the baking immediately follows plating.

RECOMMENDATIONS FOR AVOIDING OR RELIEVING HYDROGEN EMBRITTLEMENT IN CADMIUM-PLATED SPRING STEEL

The following recommendations based mostly upon the findings of this study are made for the processing and cadmium plating of spring steel to minimize hydrogen embrittlement:

(1) Cathodic treatment should be avoided in all cleaning of steel springs. Steel springs which require precleaning to avoid overburdening the final cleaning cycle should be vapor or solvent degreased or degreased by soak or anodic-type treatments in an alkaline cleaner.

(2) Oxide or scale removal by mechanical means is preferred, such as by tumbling with or without abrasive, or such as sand or vapor blasting. Care should be taken during these operations to avoid severe roughening of the surface and the production of notches in the surface. In cases where acid pickling rather than mechanical means is used for oxide or scale removal, a bake (at least 10 minutes at 400F, or 30 minutes at 250F in air; or 30 minutes in boiling water) to relieve embrittlement is recommended before proceeding with further processing and plating.

(3) It is recommended that anodic or soak-type alkaline cleaners be used for the final cleaning prior to plating. If suitable plate adhesion can be obtained by use of this type of cleaning operation, plating may then be carried out without further surface preparation or activation. Otherwise the use of an anodic etch (100 to 400 amp/sq ft) in concentrated sulfuric acid solution

(20 to 65 per cent H_2SO_4 by weight) at a temperature not to exceed 85F is recommended. The use of this treatment results in good adhesion, and is nonembrittling. The use of a short acid pickle for less than 1 minute at 75 to 85F in hydrochloric acid solution (10 per cent HCl by weight) might also be used for promoting good adhesion, though this treatment can cause some embrittlement which will require a subsequent bake to relieve. If smut forms from the hydrochloric acid pickle, it is preferable to use the anodic etch instead of the hydrochloric acid pickle followed by baking. For springs, which because of design or steel composition might be termed extremely prone to embrittlement, the short acid pickle might be dangerous, and should be avoided.

(4) Baking, if needed, will depend considerably on whether any cathodic or acid pickling was used, and somewhat on plating conditions. Cadmium-plated steel springs embrittled by cathodic or acid pickling should be baked for 24 hours at 400F. The baking time and temperature will vary for different type springs and spring sizes, and should be best established by experiment for the particular plated springs involved.

The relatively few recommendations made here are in accord with the conclusions of this research program that hydrogen embrittlement is minimized by the exercise of a few precautions mostly related to cleaning and surface preparation in the processing and cadmium plating of steel springs.

ACKNOWLEDGMENT

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ZINC PLATING OF CARBONITRIDED STEEL

By LEONARD R. KOHAN* and HOWARD T. FRANCIS**

INTRODUCTION

PLATERS HAVE FOR MANY YEARS experienced difficulty in barrel plating carbonitrided steel parts with zinc; frequently a load of parts will be partially plated, while in other instances no plating whatever will occur. In an effort to learn more about the basic cause of this difficulty, a study was undertaken in which the conditions met in barrel plating could be simulated in a simple rack-type plating cell.

Before discussing the possible mechanism whereby carbonitriding renders steel "difficult to plate," it is appropriate to review briefly the "normal" deposition of zinc on such conventional base materials as copper or unhardened steel.

Since zinc is a relatively active metal, one might reasonably expect that electrolysis of a zinc plating bath would yield only hydrogen at the cathode. Actually, of course, zinc can be deposited quite readily on most basis metals—the explanation for which is rather well understood. When a piece of metal is placed in a zinc bath and made the cathode, both hydrogen ions and zinc ions migrate toward it. The hydrogen ions are more readily discharged than the zinc ions and hydrogen gas immediately forms. This process leads to a depletion of hydrogen ions around the cathode (polarization), which causes the deposition potential of the hydrogen to shift toward the zinc deposition potential. Under ordinary conditions this shift occurs very quickly after the plating operation is started.

As soon as the deposition potential of zinc is reached, a coating of zinc appears on the cathode. The deposition potential of hydrogen is now shifted still further, due to the fact that the "hydrogen overvoltage" on zinc is much greater than on steel or copper. Under these conditions zinc deposits more readily than hydrogen, and plating proceeds at a reasonably high efficiency.

This is the sequence of events in the "normal" plating of zinc, either by rack plating or by barrel plating. In the latter method, of course, the plating action occurs in periodic "bursts," corresponding to the intermittent contact of the tumbling parts with the electrical lead or to the inaccessibility of current to parts while they are in the center of the load. This "interrupted deposition" causes no difficulty when untreated steel parts are being plated.

When steel parts with a particular kind of carbonitrided surface are barrel zinc plated, however, it is often found that the load is incompletely covered. Sometimes no deposit at all is produced on any of the parts; in other instances, some parts may accept a deposit while others remain bare or only partly covered. It is evident in these cases that the plating current has been partially or fully consumed in the evolution of hydrogen rather than in deposition of zinc.

This paper suggests a mechanism for the difficulty met in barrel plating and explains why the phenomenon is not found when the same parts are rack plated.

PRELIMINARY STUDIES

It was suspected that the difficulties found in plating carbonitrided steel were in some way connected with the hydrogen overvoltage of the treated parts. Specifically, it appeared that an exceptionally low overvoltage condition was created by carbonitriding—either over the entire surface or in discrete regions.

Furthermore, it was realized that these differences in overvoltage could be quite small and yet account for the observed plating phenomena.

Accordingly, it was decided to use a constant current plating cell arrangement, in which the bath voltage could be measured precisely during deposition. The cell employed a very large zinc anode, so that any variations in bath voltage were due solely to differences among the test specimens which served as cathodes.

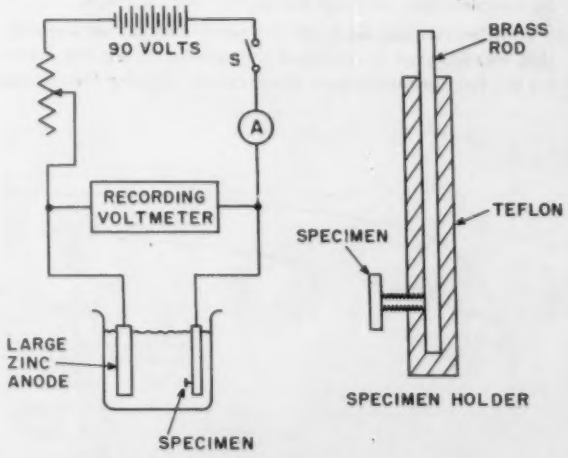

Fig. 1. Zinc plating circuit and specimen holder.

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**Armour Research Foundation of Illinois Institute of Technology, Chicago, Illinois

A small, self-tapping screw was selected for use as the test piece, since it was readily available in both the untreated and the carbonitrided conditions. The electrical circuit and the method of mounting the specimens are shown in Fig. 1.

Since the source of dc was the 90-volt battery and the current was determined almost exclusively by the value of the series resistor, the bath voltage became a direct measure of the electrochemical activity of the cathode. The anode was a large sheet of zinc, as mentioned above, and therefore functioned in a very reproducible manner in all runs.

The series resistor was adjusted to one of several fixed values, selected to give currents corresponding to cathodic current densities of 10, 30 and 50 asf.

A cyanide zinc bath of the following composition was used at room temperature for all runs:

Sodium cyanide, NaCN	5 oz/gal
Zinc cyanide, $Zn(CN)_2$	10.6 oz/gal
Sodium hydroxide, NaOH	15 oz/gal

The manner in which the Teflon rod was drilled and tapped to receive the specimen screw made it unnecessary to use any additional stop-off material. Contact with the internal brass rod was made automatically when the screw was placed in the holder.

Pretreatment of all samples was substantially the same, and consisted of the following steps:

(1) Cathodic cleaning in sodium orthosilicate (120 g/l at 180F for 1 minute).

(2) Rinse in cold running water.

(3) Pickle in 1:1 HCl (25C for 10 seconds).

(4) Rinse in cold running water.

In Fig. 2 is shown a direct comparison of the voltage-time curves for carbonitrided and untreated screws, using a current density of 10 amp/ft². It may be noted that there is a difference of 30 to 50 mv between the specimens.

The surprising fact, however, was that zinc began to deposit on both parts in the first several seconds of plating. Since a difference in bath voltage persisted even after 20 minutes, however, one must conclude that the influence of the basis metal was still evident, and that what appeared to be complete zinc coverage was in fact not complete.

Another run was made at 10 amp/ft² except that the solution was agitated by means of a magnetic stirrer; the curves for the two specimens were much closer. Raising the current density to 30 amp/ft², with agitation, brought the two curves still closer together, but a difference of about 10 mv persisted, even after 10–15 minutes. At 50 amp/ft² both parts reached the same peak voltage after approximately 3 minutes.

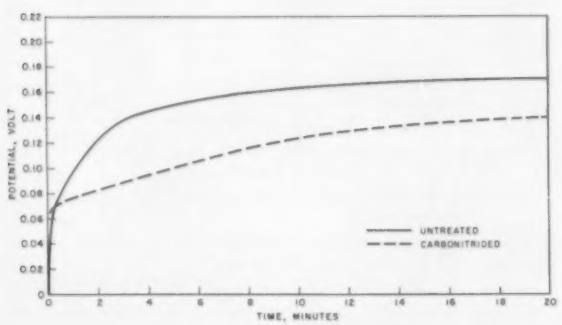

Fig. 2. Bath voltage vs time during zinc plating of untreated and carbonitrided steel. Current density, 10 asf; no agitation.

The results of these preliminary runs emphasize the differences between rack plating and barrel plating. In the former case, deposition begins when dc is applied to the bath and continues until the parts are removed from the bath. In the latter case, however, deposition occurs on a particular part only when this part is (1) in electrical contact with the negative dc terminal (either directly or through other parts), and (2) located on or near the surface of the load of parts, so that it receives at least a portion of the electrolytic current flowing from the anode. At all other times the particular piece in question is simply immersed in the plating bath, with no cathodic current reaching it.

In the case of untreated parts, it is presumed that moments of plating occur, alternating with periods of no plating. During the latter periods it is assumed that very little redissolution of zinc occurs, since rather complete coverage has been achieved during the first plating cycle; consequently, the piece is essentially homogeneous in an electrochemical sense. When another period of plating occurs, the deposit thickens. This "alternate plating and standing" repeats until the desired plating thickness is reached.

In the case of carbonitrided parts, however, it is postulated that the zinc which is deposited during a plating period is redissolved during the inactive part of the plating cycle. This could be expected, since strong cathodic sites have been shown to be present on the surface of the carbonitrided steel. These cathodes, coupled to the zinc deposit produced by plating, form local cells which lead to rapid stripping of the freshly plated zinc.

Thus, except for those pieces which happen to remain in the "plating position" for a sufficient time, no deposit will be produced, even though many ampere-hours have been applied to the load as a whole.

To summarize, it is proposed that failure to barrel plate zinc onto carbonitrided steel parts is due to an "alternately plate-and-dissolve" mechanism, as opposed to the hypothesis generally accepted by others,* viz., that deposition of zinc does not *begin* on steel parts with high-carbon cases.

If the above theory is correct, it should be possible to simulate barrel plating conditions by plating a rack-mounted part for a certain period, then allowing it to stand in the solution with no applied current. If the standing period is sufficient to cause complete stripping of the zinc deposit, no zinc will be present on the surface even after several such cycles.

SIMULATED BARREL ZINC PLATING

In this phase of the program, two batches of carbonitrided screws were studied, together with untreated screws. The second lot of carbonitrided samples were much darker in appearance than the first and were much more difficult to plate; these are referred to as "light scale" and "heavy scale" screws in the description which follows.

The general experimental procedure was to place the sample screw in the bath, pass current for a fixed time, interrupt the current for a fixed time, and to repeat this on-off sequence until a steady-state condition was reached (sometimes as long as 20 minutes).

*Gray, A. G., Modern Electroplating, John Wiley & Sons, N. Y., 1953, p. 476.

Because of the small cathode area and the relatively large anode area and large bath volume, the bath voltage required for zinc deposition was never more than 10–20 millivolts.

Depending on the state of coverage of the cathode, interruption of the current caused the bath potential to fall to zero or even to reverse (when the cathode was not completely covered by zinc).

The first sequence studied was 5 seconds on—5 seconds off, at 10 asf. The results for an untreated screw are shown in Fig. 3. It will be noted that at each interruption of the current up to point A on the curve, the bath potential reversed quickly, indicating that the cathode was very incompletely covered. Just after the current interruption corresponding to A, however, a slight "kink" in the curve may be noted, indicating that enough zinc has been deposited to delay momentarily the reversal of bath potential. At point B the delay is quite evident, and at C the bath voltage does not reverse appreciably before the current comes on again. After this point, plating evidently proceeds without appreciable resolution of the deposit during "current-off" periods. This behavior was characteristic of all specimens of non-carbonitrided screws.

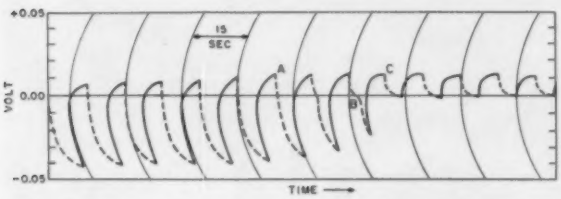

Fig. 3. Potential-time curve for untreated screw at 10 asf. Current cycle: 5 seconds on (solid line), 5 seconds off (broken line).

Figure 4 shows the data obtained when a similar plating procedure was used on a "light-scale" carbonitrided screw.

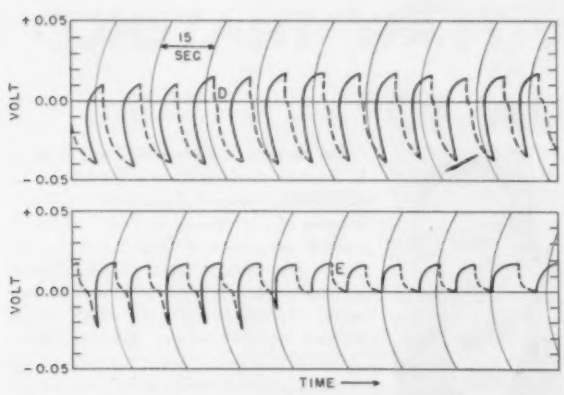

Fig. 4. Potential-time curve for "light scale" carbonitrided screw at 10 asf. Current cycle: 5 seconds on (solid line), 5 seconds off (broken line).

The electrochemical behavior was quite similar, except that a much longer time was required for the zinc coverage to become sufficiently complete to maintain zero bath potential (incomplete re-dissolution) during current-off periods (from point D to point E).

Figure 5 shows the behavior of a "heavy-scale" screw. It gave no evidence of accepting a zinc deposit, nor did it show the gradual potential changes associated with increasing zinc coverage. The bath potential actually remained below zero even during "current-off" periods.

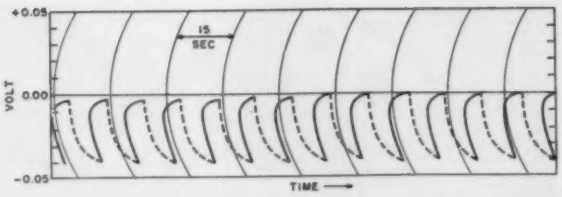

Fig. 5. Potential-time curve for "heavy-scale" carbonitrided screw at 10 asf. Current cycle: 5 seconds on (solid line), 5 seconds off (broken line).

It is clear that a load of screws of this type would be difficult if not impossible to plate in a barrel.

Several runs were made in which the on/off time ratio was changed to 5 seconds on—10 seconds off. Under these conditions an untreated screw plated fairly readily, although the time required for establishment of a "permanent" zinc coating was several minutes (as compared with a few cycles for the 5 seconds on—5 seconds off condition of Fig. 3). Again, the carbonitrided samples were difficult or impossible to plate.

Similar experiments to those described above were performed at a current density of 30 asf (instead of 10 asf). One would expect easier plating under these conditions, of course, and such was the case. The untreated and the "light-scale" samples plated readily. Even the "heavy-scale" screws finally accepted a deposit; the data are shown in Fig. 6.

It is interesting to note that the electrochemical effect of the base metal was still in evidence after plating had been in progress for a considerable period (subsequent to point P in Fig. 6). When complete coverage was achieved on an untreated screw (Fig. 3), the bath voltage tended to approach zero when current was interrupted; in the data of Fig. 6, however, the bath voltage reverts to a value characteristic of incomplete coverage. Examination of the specimen after plating revealed that the plating was spotty and that visible bare areas were still exposed.

When a "heavy-scale" specimen was plated with the 5 seconds on—10 seconds off cycle, no net deposit was observed after 20 minutes. When the current "on" period was in-

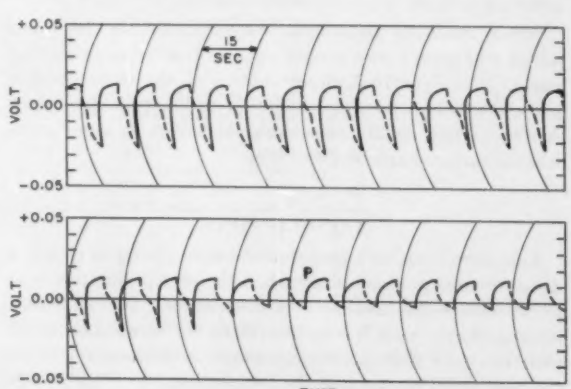

Fig. 6. Potential-time curve for "heavy-scale" carbonitrided screw at 30 asf. Current cycle: 5 seconds on (solid line), 5 seconds off (broken line).

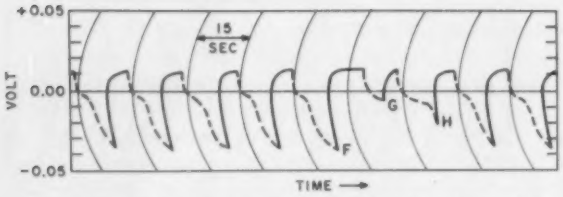

Fig. 7. Potential-time curve for "heavy-scale" carbonitrided screw at 30 asf. Current cycle: 5 seconds on (solid line), 10 seconds off (broken line). See text for explanation of phenomena at points F, G and H.

creased to 10 seconds, increased coverage occurred, but the plate redissolved when the cycle was returned to 5 seconds on—10 seconds off. This effect is shown in Fig. 7, where the "on" period was increased to 10 seconds at point F and then immediately returned to 5 seconds at G. By the next cycle (at H) the shape of the voltage curve had nearly reverted to its prior form.

SURFACE TREATMENT

In an effort to determine how deep the electrochemically active region extended on a carbonitrided specimen, samples of each type of screw were vapor blasted for periods of 5, 10 and 15 seconds. No change whatever was produced in the plating behavior of any of the three types, indicating that the material present on the surface of the "difficult-to-plate" screws had an appreciable depth in the carbonitrided surface—even on the "light-scale" screws.

Metallographic examination of the screws did not yield a clear-cut explanation of the electrochemical phenomena. The untreated screw showed the typical structure of such steel. The light-scale screw appeared to be almost 100 per cent tempered martensite, with dark spots which were thought to be oxide inclusions. The heavy-scale screw showed a very complex structure which was quite different from the other samples. It appeared to contain retained austenite just below the surface, with a thin film of martensite at the surface.

It should be emphasized that no attempt was made to correlate the electrochemical properties of the carbonitrided screws with their metallurgical structure. Rather, the principal aim of the work was to determine by what mechanism some parts failed to receive a zinc coating.

While chemical treatments may undoubtedly be found which will permit zinc plating even of heavily carbonitrided parts, it is clear that closer control of the carbonitriding process will also provide a solution to the problem. Such control is not readily achievable, however, in many commercial surface-hardening facilities.

CONCLUSIONS

Zinc deposition on a part during barrel plating is clearly a discontinuous process. Only when the part in question is at the surface of the load can deposition occur. When the part is buried in the load, it is quite evident that re-solution of the plate can take place if sufficient couple action exists between the base metal surface and the zinc deposit.

On untreated parts, the re-solution action is very slow—plating is easy. On carbonitrided parts, the re-solution rate is very dependent on the degree of electrochemical cathodic action which is induced by the surface-hardening treatment. If the carbonitriding is "heavy"—and the precise meaning of this term is admittedly not at all clear—dissolution of the zinc during non-plating periods occurs very rapidly and, as a result, no net plating is produced on the parts.

None of the treatments which might be expected to yield successful zinc plating on all types of carbonitrided parts were successful. Various pickling treatments, immersion plating steps, and even extremely severe pickling were not at all effective in inducing zinc deposition with no re-dissolution.

It is hoped that the technique of barrel-plating-simulation described earlier may be useful in further study of this and other problems.

ACKNOWLEDGMENT

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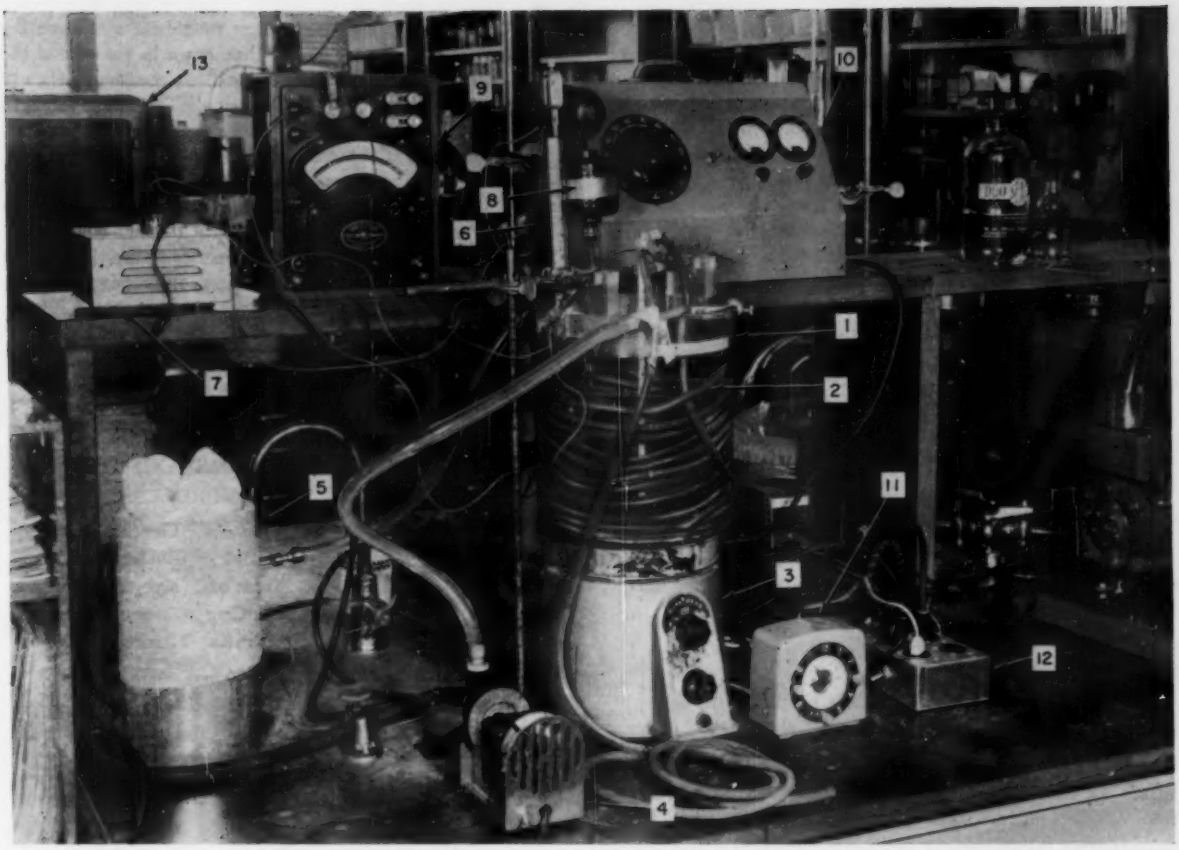

Fig. 1. Hard-coating apparatus. (1) Battery jar, (2) cooling coils and cathodes, (3) magnetic stirrer, (4) cooling fluid pump, (5) flask, (6) regulator, (7) electronic relay, (8) stirrer motor and glass stirrer, (9) watt meter, (10) power supply, (11) electric interval timer, (12) electric junction box, (13) electric oven.

CONSTANT WATTAGE HARD ANODIZING OF ALUMINUM*

by MARTIN A. BLUMENFELD† and W. FRED SCHURIG‡

ABSTRACT

The work covered in this paper concerns a study of hard anodic coatings of one to 4 mils applied to 6061-T6 Aluminum Alloy using constant wattage dc power, in place of the constant current source presently employed in the hard anodizing industry. A study was made of the effects of temperature, wattage, and treatment time on the rate of build up of the anodic coating, and their relation to abrasion resistance and dielectric breakdown voltage. A comparison was made between the properties obtained from hard anodized coatings applied with the use of constant wattage to those obtained from the Martin Hard Coating Process and the Aluminum Company of America's Alumilite No. 226 Process.

INTRODUCTION

SINCE THE FIRST applications of anodizing by Bengough and Stuart[1] (chromic acid) and Cower and O'Brien[2] (sulfuric acid) this finish has taken enormous strides in our industry. Anodizing truly came into its own during the Second World War, when the government demanded the light weight of aluminum coupled with rigid corrosion resistance requirements.

The first work carried out in the production of thick hard anodic coatings for engineering applications with oxalic acid are described by Schenk[3] and with sulfuric acid by Tomashov[4]

*Based on Master's Thesis in Chemical Engineering at The Polytechnic Institute of Brooklyn, N. Y.

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and Smith.[5] Tomashov showed that by cooling the sulfuric acid electrolyte, thus slowing down the rate of dissolution of the oxide, coatings of up to 10 mils could be obtained with excellent wear resistance and heat insulation. A number of commercial hard anodizing processes have been developed using direct current or superimposed ac on dc. One of the best known of these processes is The Martin Hard Coat Process** developed by the Glenn L. Martin Company which uses a 15 per cent sulfuric acid electrolyte operated at 25 amp/ft², a temperature of 0°C, and saturated with carbon dioxide. Still another process in common usage today is the process*** developed by the Aluminum Company of America. This process employs a mixed electrolyte of 130 g/l sulfuric acid plus 14 g/l oxalic acid and is operated at 36 amp/ft² and a temperature of 8 to 10C. Both these dc processes are limited to alloys containing less than 3 per cent copper or 7.5 per cent silicon. A process using superimposed ac on dc current was developed by Campbell[6] and is known commercially as the Hardas process. Campbell uses a 6 per cent oxalic acid solution at 4C with a varying ac component superimposed on 60 volts dc. More recently a 10 per cent sulfuric acid electrolyte has been used with ac superimposed on dc, at a temperature of 0 to 5C. The use of ac on dc permits the hard coating of high copper containing alloys.

PROPERTIES OF HARD COATINGS

Much data have been compiled on the Martin Hard Coat process and the Alumilite process and their subsequent coatings. An excellent survey of the mechanical properties of hard coatings on various alloys is given by Johnson[7] in which he discusses fatigue strength, tensile strength, compressive strength, corrosion resistance and abrasion resistance. A thorough study of these processes was also conducted by Gillig[8] and Vanden Berg.[9] Some of these data are given in Tables I and II.

The color of the coating is a function of the alloy being treated, the thickness of the deposit, and operating variables such as bath temperature and current. Hard coatings tend to craze, and a distinct cracking is audible if a freshly deposited coating is held against the ear. The throwing power of the Martin Hard Coating Process is reported as being excellent. Sealing of hard coatings is omitted as this operation softens the deposit. Hard coatings afford excellent protection against salt spray environments for all alloys except the high copper containing alloys, e.g., 2 mil coatings on 6061-T6 passed 330 days of salt spray testing while the same thickness of coating on 2024 failed within 90 days. It was also found that coatings more than 3 mils thick are not as corrosion resistant as those in the 2-to-3-mil range. This is attributed to the increased porosity of the heavier coatings. Dielectric breakdown voltages up to 3750 volts have been given by the Glenn L. Martin Company for hard anodizes. Sealing increases the dielectric breakdown resistance of the coatings. Good heat resistance is shown by hard anodized aluminum, however, above 200F checking of the film occurs. The coating shows no tendency to spall and the checking does not appear to affect its corrosion resistance. A coefficient of friction for hard anodizing has been reported as being 0.11 with maximum wear resistance being obtained with a lubricant of molybdenum sulfide or graphite grease. Since hard coatings generally increase surface roughness and have the property of being softer on top than down in the core of the coating it is the usual practice to anodize oversize and then to lap down to the final desired dimension. The tensile strength is reduced in proportion to the thickness of the coating. Reduction in yield strength ranges from 2.5 to 11.8 per cent on 7075-T6 alloy as the coating thickness is raised from 1 to 5 mils. In compressive strength the coating is at least as strong or stronger than the base metal (50,000–60,000 psi). For design purposes it is standard practice to use the original area of the parent metal for calculating compressive strength.

TABLE I[9]

ABRASION DATA ON VARIOUS ALLOYS FOR THE MARTIN HARD COAT AND THE ALUMILITE No. 226 PROCESS

Alloy	Coatiug	Thick-ness of Coating in mils	Grams of Abra-sive to Wear Through	Grams of Abra-sive per mil of coating
1100	Alumilite 226	2.24	387	173
	Martin Hard Coat	2.77	405	146
3003	Alumilite 226	2.33	368	158
6061-T6	Alumilite 226	2.15	364	169
	MHC	2.31	390	169
7075-T6	Alumilite 226	2.13	357	168
2024-T3	Alumilite 226	2.10	142	68
	MHC	2.48	163	66

No. 180 grit emery employed at pressure of 5 psi.
Orifice dia = 11/64 in.

APPLICATIONS FOR HARD COATINGS

Hard anodic coatings for aluminum alloys are of considerable interest to the aircraft industry. Here a light metal with a hard, wear resistant finish offers a valuable replacement for parts produced from heavier metals of higher inherent hardness. Such applications include gears, pinions, bearing races, gun blast tubes, slides, pistons and helicopter blade edges. Hard anodic coatings are coming into wider use in applications where electrical insulation is desired. One such case are transistor mounts. In prior designs, mica or some other organic nonconductor was placed between the transistor and heat radiation source. The purpose of the mica mount was to electrically insulate the transistor from the radiator. However, considerable loss in heat transfer occurred due to the use of mica (a very poor thermal conductor) with a resulting failure in transistor operation from overheating. If the radiator surface in contact with the transistor is hard coated, a considerable rise in heat transfer over the old mica system results, without the loss of the electrical insulation property. This results in considerably fewer transistor rejects due to overheating.

**U. S. Patent 2,692,851 and Patent 2,692,852.
***Alumilite No. 226 Process described in Aluminum Company of America Bulletin No. 14.

TABLE II[7]

ENDURANCE STRENGTH OF HARD COATED ALUMINUM

Alloy	Endurance Strength at 10^6 Cycles in psi		Decrease in Endurance Strength
	Uncoated	Coated	%
6061	15,000	6000	60
2024 clad	11,000	7500	32
2024 base	19,000	15,000	1
7075 clad	12,000	10,000	17
7075 base	22,000	9000	59
220	7500	7500	0
356	8000	8000	0

EXPERIMENTAL

In 1957 Kape[10] investigated the use of a constant wattage dc source of power for applying hard anodic coatings to aluminum. The following conclusions regarding constant wattage hard coating are given by Kape in his paper:

a. Films formed using a constant wattage method may be produced thicker under the same conditions of treatment than those processed using a constant current density.

b. The rate of formation of the anodic film is higher the greater the value of the constant wattage. Correspondingly, the rate of change of voltage with time is greater the higher the wattage.

c. The forming voltage is approximately the same whatever the value of the constant wattage, but is raised by lowering the temperature or decreasing the acid concentration.

d. Using constant wattage, the rate of change of voltage is greater with electrolytes of high concentration.

e. The specific abrasion resistance of the anodic film is generally higher at higher wattages and low acid concentrations. Lowering the temperature below 10C has no great effect, but temperatures of 15C and above cause a considerable fall in specific abrasion resistance.

This work was the basis for the research conducted by the authors on Aluminum Alloy 6061-T6.

The hard anodizing operations were carried out in the apparatus shown in Fig. 1. It consisted of the following equipment the numbers of which correspond to those on the photograph:

1. Three-gallon Pyrex battery jar.
2. Lead cooling coils and cathodes.
3. Gyratherm magnetic stirrer.
4. Rupp Pump—for pumping cooling fluid.
5. De War flask—Cold source (dry ice and methanol).
6. Merc-Merc-Thermo regulator—controlled the temperature of the bath by activating the electronic relay which in turn started the Rupp Pump.
7. Electronic relay.
8. Stirrer motor and glass stirrer.
9. Weston dc watt meter.
10. DC high voltage power supply—½ wave filtered dc—0–110 volts—15 amperes.
11. Electric interval timer.
12. Electric junction box.
13. Electric oven—to bake stop-off lacquer.

The properties of the anodic coatings formed were evaluated using the following methods:

1. Thickness Testing.
   a. Mechanical—one-inch four-place micrometer.
   b. Visual—Bausch and Lomb binocular microscope with a filar eye piece. (500×.)
   c. Electrical—Dermitron—non-destructive electronic thickness gage which employs eddy currents. In order to use the instrument for determining anodic coating thicknesses, standards were prepared by the authors and calibrated using metallographic cross sectioning. A direct reading scale of 0 to 2.4 mils and a calibration curve from 2.4 to 4.0 mils were obtained from the instrument's manufacturer.*
2. Dielectric Breakdown Voltage.
   a. A spring loaded fixture with two ¼-inch electrodes to make electrical contact on both sides of the test panel was used. Both ac and dc monitored voltages were then applied per ASTM D149 and the breakdown potential of the coating determined.
3. Hardness and Abrasion Tests.
   a. Tukon hardness tester—An instrument which measures the indentation hardness of materials. An impression was made on the test panels by a standard Vickers 136° diamond pyramid under a 100-gram load.
   b. Taber Abraser—An instrument which incorporates a rotary rub wear principle of abrasion. Two CS 17 calibrase wheels each under a 1000-gram load were used for abrasives. The panels were weighed before and after a controlled number of abrasion cycles. The weight change was taken as a measure of the abrasion resistance of the coating being studied.
   c. Abrasive jet apparatus—The instrument described by Deal[11] was used for these measurements. An abrasive powder (Al_2O_3) is propelled from a vibrating storage chamber, under controlled gas (CO_2) pressure onto the coating being tested. The time to abrade through the hard coat was taken as a measure of its abrasion resistance.

*Unit Process Assemblies Inc., N. Y., N. Y.

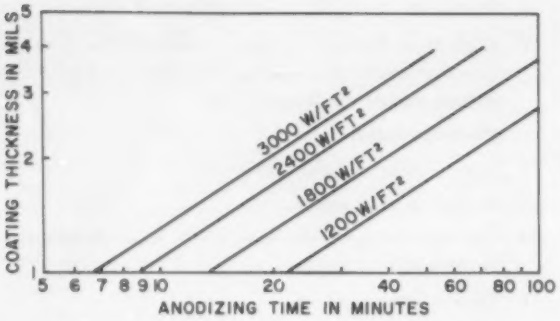

Fig. 2. Anodizing time vs. coating thickness (0°C).

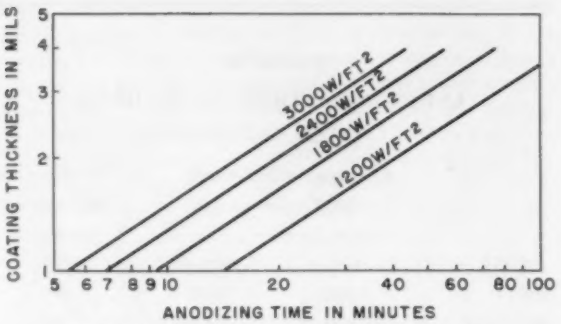

Fig. 3. Anodizing time vs. coating thickness (10C).

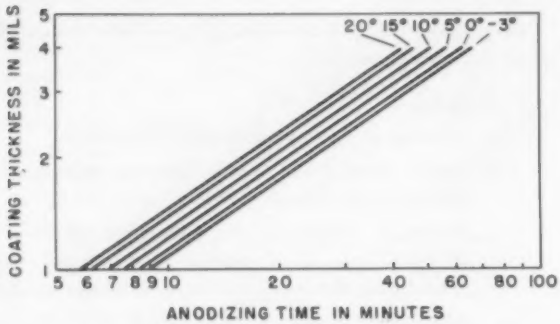

Fig. 4. Anodizing time vs. coating thickness (2400 w/ft²).

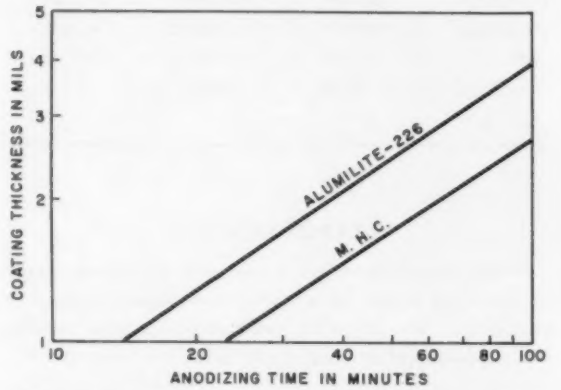

Fig. 5. Anodizing time vs. coating thickness (conventional hard coats).

Hard anodizing was conducted in the Alumilite No. 226 bath (130 g/l H_2SO_4 + 14 g/l oxalic acid).

All test specimens to be coated were held in a screw type fixture constructed out of 6061-T6 aluminum. This type of rack allows good electrical contact with the test specimen. The test specimens were Alloy 6061-T6—3.5 by 3.5 by 0.040 in. with a ¼-in. hole drilled through the center to allow for both abrasion testing and racking. They were cleaned prior to coating in the following manner:

a. Vapor degrease with trichlorethylene.
b. One minute etch in a 6 oz/gal solution of NaOH (Temp = 200–210F).
c. Water rinse.
d. 30 second dip in 50 per cent HNO_3.
e. Water rinse.
f. Dry and stop-off one side of panel with 3 coats of a vinyl base lacquer.
g. Five minute cleaning in 6 oz/gal Oakite No. 61 non-etch aluminum cleaner.
h. Water rinse.
i. Anodize.

Test panels were prepared at 10C and 0°C at constant wattage densities of 3600, 3000, 2400, 1800, and 1200 w/ft² at times of 5 to 90 minutes. Temperatures of 20°, 15°, 5° and −3° were also used at 2400 w/ft². Similar specimens were prepared using the Martin Hard Coat and Alumilite No. 226 processes. These panels were used for the thickness and dielectric voltage determinations. Test specimens with 0.002 in. coatings were then prepared in triplicate at all the above mentioned operating conditions for abrasion testing. This thickness was selected since it is the one most often specified for engineering applications. Test specimens were also prepared in triplicate for abrasion testing with the following coatings:

a. Chromic acid anodize.
b. H_2SO_4 anodize—no seal.
c. H_2SO_4 anodize—hot water seal.
d. H_2SO_4 anodize—dichromate seal.

TEST RESULTS

A general equation relating time, temperature and wattage density to coating thickness was determined to be as follows:

$$D = [(-1.8 \times 10^{-10}\,T + 8.8 \times 10^{-6})\,W + 4.1 \times 10^{-6}\,T + .23 \times 10^{-4}]\,\Theta^{2/3}$$

D = coating thickness in inches.
T = bath temperature °C.
W = wattage density (w/ft²).
Θ = treatment time in minutes.

It was also found that the coating thickness of the Martin Hard Coat and Alumilite No. 226 processes also was related to the treatment time to the 2/3 power.

The experimental data obtained are presented in Figs. 2 to 5.

It was found that the use of constant wattage considerably speeds up the time necessary to obtain a 0.002 in. coating. These data are given in Table III. The table shows that a 0.002 in. coating can be applied by the constant wattage process in

approximately one-half the time required in the Alumilite No. 226 process and one-third the time required in the Martin Hard Coat process. This occurs because of the higher current densities employed in the constant wattage process.

The dc voltage breakdown of the hard coating is approximately 56 per cent higher than the ac voltage breakdown. A 0.002 in. coating gave average values of 1450 and 925 volts respectively. This insulation appeared to be only a function of the thickness of the coating and not the manner of application. All values of electrical breakdown were taken on flat dry surfaces. Sharp edges or corners gave false readings and in some cases showed no electrical insulation. Any moisture on the hard coat surface will penetrate the pores of the coating and give very low voltage breakdown readings, in most cases zero volts. Figure 6 represents the insulation data obtained for the various thicknesses of hard coating.

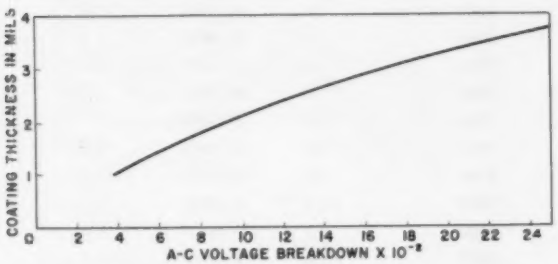

Fig. 6. Thickness of hard coat vs. average a-c voltage breakdown.

The Dermitron gave good values for coating thicknesses and generally agreed with the cross sectional values within 10 per cent or better. These data are presented in condensed form in Table IV. The use of the Dermitron as a nondestructive means of determining hard coat thickness is recommended.

The Taber Abraser and Tukon hardness tester were unsatisfactory for determining and comparing wear properties of hard coatings. The former because of its time consuming operation and the tendency to pick up particles, and the latter due to the brittle nature of the coating. Optimum abrasion resistance, as determined by the abrasive jet test,

TABLE III

TIME NECESSARY TO OBTAIN A HARD COATING OF 0.002 IN.

Process	Bath Temperature °C	Treatment Time Minutes
3000 w/ft²	10	15
2400 w/ft²	20	16
2400 w/ft²	15	18
3000 w/ft²	0	18
2400 w/ft²	10	20
2400 w/ft²	5	22
2400 w/ft²	0	24
2400 w/ft²	−3	26
1800 w/ft²	10	27
1800 w/ft²	0	37
Alumilite 226	10	38
1200 w/ft²	10	40
1200 w/ft²	0	60
MHC	0	65

TABLE IV

THICKNESS MEASUREMENTS OF HARD COATINGS USING METALLOGRAPHIC CROSS SECTIONING AND DERMITRON

Process	Bath Temperature °C	Treatment Time Minutes	Thickness by Metallographic Cross Section in inches	Thickness by Dermitron in inches
3000	10	14	0.0018	0.0018
3000	10	21	0.0024	0.0023
3000	10	35	0.0039	0.0036
3000	0	14	0.0017	0.0017
3000	0	21	0.0022	0.0022
3000	0	35	0.0030	0.0030
2400	20	20	0.0023	0.0021
2400	20	40	0.0037	0.0035
2400	20	60	0.0048	0.0045
2400	15	20	0.0022	0.0023
2400	15	40	0.0036	0.0035
2400	15	60	0.0043	0.0042
2400	10	20	0.0020	0.0019
2400	10	40	0.0029	0.0032
2400	10	60	0.0043	0.0042
2400	5	20	0.0020	0.0020
2400	5	40	0.0030	0.0030
2400	5	60	0.0037	0.0035
2400	0	20	0.0018	0.0018
2400	0	40	0.0029	0.0026
2400	0	45	0.0030	0.0030
2400	−3	20	0.0017	0.0018
2400	−3	40	0.0026	0.0024
2400	−3	60	0.0032	0.0032
1800	10	24	0.0020	0.0020
1800	10	48	0.0030	0.0030
1800	10	72	0.0040	0.0040
1800	0	24	0.0015	0.0017
1800	0	48	0.0023	0.0025
1800	0	72	0.0033	0.0033
1200	10	30	0.0016	0.0018
1200	10	60	0.0026	0.0025
1200	10	90	0.0035	0.0036
1200	0	30	0.0013	0.0015
1200	0	60	0.0020	0.0022
1200	0	90	0.0027	0.0024
Alumilite 226	10	30	0.0016	0.0015
Alumilite 226	10	45	0.0022	0.0021
Alumilite 226	10	60	0.0027	0.0029
MHC	0	30	0.0014	0.0013
MHC	0	60	0.0019	0.0018
MHC	0	80	0.0024	0.0024

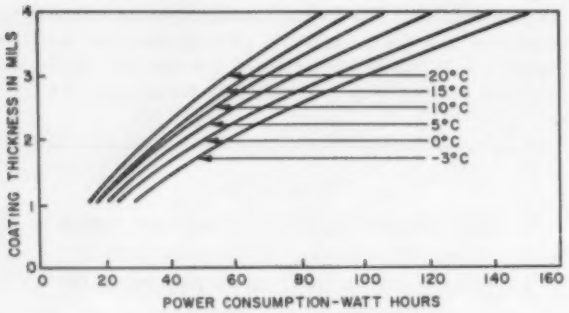

Fig. 7. Power consumption vs. thickness of hard coating (2400 w/ft²).

was obtained at a constant wattage density of 2400 w/ft². Temperatures of 10C or lower did not effect the abrasion resistance of the hardcoats while those in excess of 10C considerably softened the deposit. The abrasion resistance of coatings applied with 2400 w/ft² at temperatures of 10C or lower were as hard as those produced by either the Martin Hard Coating process or the Alumilite No. 226 process. The hard anodic coatings were more abrasion resistant than conventional anodizing which was also softened by sealing. The abrasion data are presented in Table V.

A constant wattage density of 3600 w/ft² was too high to use in anodizing. Considerable burning and part destruction occurred at this density. More rapid agitation was necessary when hard coating with constant wattage than with constant current due to the high initial current (100 A/ft²) used in the former. Good electrical contact was necessary due to the high voltages and currents employed and also the insulating character of the deposits formed.

The final processing voltages obtained for 2 mil coatings are given in Table VI. The lower operating temperatures gave the higher operating voltages. This was due to a rise in solution resistivity with a drop in temperature. The higher wattages gave lower voltages. This condition was attributed to a decrease in electrical resistance on the coated surfaces due to localized heating resulting from high wattage density operations.

The power consumed in hard coating did not appear to depend on the operating wattage density but rather on the operating temperature of the bath. These data are presented in Fig. 7.

CONCLUSIONS

Considerable time savings, and thus, a reduction in labor costs results from the use of constant wattage in hard coating. However, it should be noted that the capital costs of a constant wattage hard coat plant compared to a constant current installation would be higher due to the larger capacity rectifiers and refrigeration units required.

Based on the data obtained it is felt that the optimum operating conditions for constant wattage hardcoating of 6061-T6 aluminum alloy is a wattage density of 2400 w/ft² and a temperature of 10 to 5C. The 2400 w/ft² wattage density gave optimum abrasion results at the above temperatures as well as at 0°C and −3C. However, the use of the

TABLE V

ABRASION RESISTANCE OF HARD COATINGS

Process	Bath Temp °C	Thickness of Coating	Abrasive Jet Test (sec/mil)
3000	10	0.0024	1.5
3000	10	0.0024	1.4
3000	10	0.0024	1.5
3000	0	0.0022	1.8
3000	0	0.0021	1.6
3000	0	0.0022	1.8
2400	20	0.0026	1.1
2400	20	0.0025	1.2
2400	20	0.0024	1.3
2400	15	0.0026	1.2
2400	15	0.0026	1.2
2400	15	0.0025	1.3
2400	10	0.0022	1.7
2400	10	0.0022	1.7
2400	10	0.0021	1.9
2400	5	0.0025	1.7
2400	5	0.0024	1.7
2400	5	0.0023	1.9
2400	0	0.0021	1.8
2400	0	0.0020	1.9
2400	0	0.0022	1.9
2400	−3	0.0016	1.8
2400	−3	0.0021	1.8
2400	−3	0.0021	1.8
1800	10	0.0022	1.3
1800	10	0.0021	1.4
1800	10	0.0021	1.3
1800	0	0.0013	1.5
1800	0	0.0022	1.6
1800	0	0.0022	1.6
1200	10	0.0017	1.4
1200	10	0.0018	1.2
1200	10	0.0017	1.6
1200	0	0.0020	1.7
1200	0	0.0022	1.6
1200	0	0.0022	1.6
MHC	0	0.0016	1.7
MHC	0	0.0017	1.6
MHC	0	0.0017	1.8
Alumilite 226	10	0.0019	1.9
Alumilite 226	10	0.0019	1.8
Alumilite 226	10	0.0019	1.8
H_2SO_4 no seal	20	0.0007	1.0
H_2SO_4 no seal	20	0.0007	1.3
H_2SO_4 no seal	20	0.0006	1.4
H_2SO_4 H_2O seal	20	0.0007	1.1
H_2SO_4 H_2O seal	20	0.0007	1.0
H_2SO_4 H_2O seal	20	0.0007	1.1
H_2SO_4 dichrom seal	20	0.0007	0.9
H_2SO_4 dichrom seal	20	0.0006	1.1
H_2SO_4 dichrom seal	20	0.0007	0.9

TABLE VI

FINAL PROCESSING VOLTAGES WHEN A 0.002 IN. COATING WAS BUILT UP

Process	Bath Temp °C	Final Operating Voltage	Final Current Density, amp/ft²
3000	10	43	70
3000	0	55	54
2400	20	34	70
2400	15	38	63
2400	10	43	56
2400	5	55	44
2400	0	58	41
2400	−3	75	32
1800	10	50	36
1800	0	65	28
1200	10	50	24
1200	0	75	16
MHC	0	70	25
Alumilite 226	10	38	36

latter two temperatures would only slow down the anodizing process and at the same time increasing power cost without buying any additional wear properties. The lower temperatures would also require a larger refrigeration unit and would cost more in refrigeration power to operate.

It should be remembered that the work herein was obtained in the laboratory, and the constant wattage process has yet to be proven commercially.

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He began his professional career in 1952 as a metal finishing development engineer at The Western Electric Company in Kearny, N. J. During 1955 and 1956 he was in the U. S. Army Signal Corps as a radar repairman. In 1956 he became a chemist in the electrochemical group of the Materials Laboratory of the Sperry Gyroscope Company in Great Neck, N. Y. in which capacity he is currently employed.

Mr. Blumenfeld is an active member of the American Electroplaters' Society, The Electrochemical Society, The Faraday Society and The Institute of Metal Finishing. He has authored several papers which have been presented to the New York Branch of the AES. He is also an associate member of the Society of the Sigma Xi.

Dr. W. Fred Schurig was born in Brooklyn in 1912. He received the Bachelor, Master and Doctor of Chemical Engineering degrees from the Polytechnic Institute of Brooklyn.

During the years 1934 to 1938 he was employed as a chemical engineer by the Gray Chemical Co., American Sugar Refining Co., Columbia Southern Alkali Co. and Allied Chemical and Dye Co. He was an assistant professor of chemical engineering at The College of the City of New York from 1938 to 1947 and has been a professor of chemical engineering at The Polytechnic Institute of Brooklyn from 1947 till the present date. He was also a visiting professor of chemical engineering to The University of San Carlos, Guatemala, C. A. in 1957.

Dr. Schurig is an active member in The American Institute of Chemical Engineers and the American Chemical Society. Among his honors are included membership in the Society of the Sigma Xi—honorary research society. Tau Beta Pi—honorary engineering society. Phi Lambda Upsilon—honorary chemistry society. Omicron Chi Epsilon—honorary chemical engineering society. Professor Honorario of the University of San Carlos.

He is a licensed professional engineer of the State of New York. He has authored several publications in "Industrial and Engineering Chemistry" and has served as consultant to some 15 to 20 Latin American and Canadian Universities.

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AMERICAN ELECTROPLATERS' SOCIETY

1960-1961

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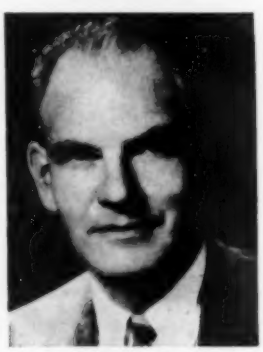

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AES NEWS

PLATING MAGAZINE'S MONTHLY CALENDAR OF AES EVENTS

The business of AES is education, and education in the arts and sciences of electroplating, metal finishing, organic coating and allied arts abounds at practically every AES Branch monthly meeting, particularly, on larger scale, at AES National Conventions and at Regional and Branch Annual Meetings.

Information concerning such meetings is not only regularly carried in PLATING MAGAZINE'S monthly AES news columns but the PLATING section titled "Future Meetings" appearing in every monthly issue also lists those of such events, chronologically, whose details have been submitted to PLATING for such purpose. See this month's edition on Page 1214, for example.

If your Region's or Branch's major 1960–1961 educational meeting is not now listed in that calendar of AES events, your Region or Branch has not yet reported it to PLATING. To remedy the omission, send those data today.

And do make a practice monthly of checking the "Future Meetings" section of PLATING for information concerning those meetings conveniently near to you that you can and ought to attend as an AES member in good standing for enrichment of knowledge and therefore for self betterment.

♦

AES THANKS . . .

The Society expresses its warm thanks to the Metal Finishing Suppliers' Association (MFSA) for the fellowship and fun provided to AES members during "off duty" hours at the AES's recent 47th Annual Convention (Los Angeles, July 24-28, 1960) through the Convention events sponsored by the MFSA, including 1) the MFSA Ball (July 25), 2) the Golf Tournament (July 26) and 3) the Pre-Banquet Cocktail Party (July 28).

AES also thanks each and every individual industrial company that sponsored plant tours—or "get-togethers", luncheons or other relaxational, "off duty" hour events at the Convention.

It also extends its appreciation to the Hanson-Van Winkle-Munning Company for providing its delightful daily Convention tabloid so greatly enjoyed daily by AES members, their families and their Convention guests for the twenty-sixth consecutive year.

P. R. Dickinson

E. L. Lorenzen

NEWEST BRANCH TO BE ADMITTED AT OCTOBER MEMPHIS MEETING

The Memphis-Midsouth Branch, AES's 59th and most recently chartered Branch, will be officially installed by an installing team of National officers headed by National President W. Andrew Wesley at an appropriate event in Memphis, Tennessee, the evening of October 21.

Aside from receiving its Permanent Charter at the hands of President Wesley, as a full-fledged element of the AES's family of chartered Branches in the United States, Canada and Australia, the infant Branch's first elected officers will also be installed in office by Dr. Wesley, namely Edward L. Lorenzen, President; James R. Lee, First Vice President; William Neumeister, Second Vice President; Phillip R. Dickinson, Secretary-Treasurer; Michael Derden, Branch Librarian and James R. Lee, Branch Research Finance Chairman. Messrs. C. E. Herndon, Frank G. Donofrio and John H. O'Neal compose the Memphis-Midsouth Branch's first Board of Managers.

After formal installation as the AES's 59th Branch and welcome to it as a member of AES's Dixie Regional Council, the Memphis-Midsouth Branch will be eligible to receive the $100 purse of the "Thomas A. Trumbour Memorial Award" of the Metal Finishing Suppliers' Association (MFSA) that is now awarded to new AES chartered Branches by MFSA after AES installation.

BRANCHES POLLED FOR CANDIDACIES FOR HIGH AES 1960-1961 HONORS

All AES Branches have now received opportunity through official Return Sheets recently sent by National Headquarters, to nominate candidates for 1) the 1960–1961 AES Scientific Achievement Award and 2) AES Honorary Membership. The specifications for each honor not only accompanied the Return Sheets but are also spread in the Appendix of the AES Constitution and Bylaws booklet (as of June 18, 1959) possessed by all Branches and their Delegates/Alternates. (See also PLATING, September 1959.)

Deadline for all Branch nominations for the AES Scientific Achievement Award is by or before October 15, 1960; for AES Honorary Membership by or before November 15, 1960. Each executed Return Sheet filed with the National Executive Secretary by deadline must be signed as specified, and each must be accompanied by the requisite number of copies of profiles of the qualifications of endorsed candidates.

Similar Return Sheets will soon issue to all AES Branches and to all AES Committees for candidates for the 1960–1961 Charles Henry Proctor Memorial Leadership Award.

1960 — 1961
COMPOSITION AND LEADERSHIP
REGIONAL AND BRANCH STRUCTURE FOR PROMOTION OF AES BRANCH MEMBERSHIP, AMERICAN ELECTROPLATERS' SOCIETY, INC.

I AUSTRALIAN REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Bruce Leslie, Victoria, Australia

1. ADELAIDE: D. McNamara, Dunleath, So. Australia
2. MELBOURNE: Ian W. Rose, Glen Ormond, Victoria, Australia
3. SYDNEY: Clive J. Jones, Revesby, N.S.W., Australia

♦

II DIXIE REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: George W. Taylor, Adel, Georgia

4. BLUE RIDGE: Carl A. Witherspoon, Blacksburg, Virginia
5. MEMPHIS-MIDSOUTH: James R. Lee, Memphis, Tennessee
6. MIAMI: Earl Kennedy, Miami, Florida
7. SOUTHEASTERN: Vince L. Cashen, Carrollton, Georgia

♦

III EASTERN CANADIAN REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Stanley A. Frost, Verdun, Quebec, Canada

8. HAMILTON: Bruce Connolly, Hamilton, Ontario, Canada
9. MONTREAL: Bruce B. Millward, Longueuil, P.Q.
10. TORONTO: Roan H. Clark, Toronto, Ontario, Canada
11. WESTERN ONTARIO: Robert T. Dobson, Watford, Ontario, Canada

♦

IV EMPIRE STATE REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: John J. Bunsic, Binghamton, New York

12. BUFFALO: John G. Donaldson, Warren, Pennsylvania
13. CAPITOL DISTRICT: Edwin Frieberg, Albany, New York
14. MOHAWK VALLEY: Theodore Duvall, Utica, New York
15. ROCHESTER: Charles B. Fideor, Rochester, New York
16. SYRACUSE: Edwin C. Elliott, Geneva, New York
17. SOUTHERN TIER: Bruce Wells, Endicott, New York

♦

V KEYSTONE STATE REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: J. E. Cogan, Philadelphia, Pennsylvania

18. ALLENTOWN-READING: Homer Ressler, Bethlehem, Pennsylvania
19. LANCASTER: George H. Geesey, York, Pennsylvania
20. PHILADELPHIA: Irvin K. Hauseman, Pottstown, Pennsylvania
21. PITTSBURGH: Richard E. Woehrle, Steubenville, Ohio

♦

VI METROPOLITAN REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Manuel Ben, Oak Park, Michigan. (Protem)

22. NEW YORK: Jack Weiner, Fresh Meadows, L. I., New York
23. NEWARK: A. Korbelak, Nutley, New Jersey
24. BALTIMORE-WASHINGTON: Lancaster Lowry, Mt. Ranier, Maryland

♦

VII MIDWEST REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: George E. Parisho, Bettendorf, Iowa

25. CHICAGO: Rudy J. Hazucha, Chicago, Illinois
26. MILWAUKEE: Arthur M. Linn, Kenosha, Wisconsin
27. MISSISSIPPI VALLEY: Wilbur F. McKay, Hampton, Illinois
28. ROCKFORD: Charles Miner, South Rockford, Illinois
29. ST. JOSEPH VALLEY: Jack W. Petersen, South Bend, Indiana
30. ST. LOUIS: Homer P. Thomen, St. Louis, Missouri

♦

VIII NEW ENGLAND REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Robert D. Martin. Denver, Colorado (Protem)

31. BOSTON: F. Wayne Martin, Belmont, Massachusetts
32. BRIDGEPORT: William Lindsay Jr., Orange, Connecticut
33. HARTFORD: Stanley Grabowski, Bristol, Connecticut
34. NEW HAVEN: Edward R. Jorczyk, Bridgeport, Connecticut
35. PROVIDENCE-ATTLEBORO: C. L. Capobianco, No. Providence, Rhode Island
36. SPRINGFIELD: Louis E. Dupuis, Fairview, Massachusetts
37. WATERBURY: Louis Porretti, Waterbury, Connecticut

♦

IX SOUTHWESTERN REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Myron E. Browning Jr., Fort Worth, Texas

38. DENVER: Robert L. Whyman, Denver, Colorado
39. DALLAS-FT. WORTH: Robert F. Howard, Forth Worth, Texas
40. HOUSTON: Dale E. Chapman, Houston, Texas
41. KANSAS CITY: William E. DesJardins, Leawood, Kansas
42. PHOENIX: (Notification Awaited)
43. WICHITA: Max Brinnon, Wichita, Kansas

♦

X TRI-STATE REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: M. Lester Reynolds, Indianapolis, Indiana

44. CLEVELAND: Gordon Carlson, Elyria, Ohio
45. COLUMBUS: Charles Kayser, Columbus, Ohio
46. CINCINNATI: Gerard H. Poll Jr., Cincinnati, Ohio
47. INDIANAPOLIS: Stephen O'Connor, Indianapolis, Indiana
48. DAYTON: Lawrence H. Hadlock, Dayton, Ohio
49. LOUISVILLE: James R. Smith, Louisville, Kentucky

♦

XI WEST COAST REGIONAL MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: L. Truman Stoner, Norwalk, California

50. BRITISH COLUMBIA: William T. Kilby, Vancouver, British Columbia
51. LOS ANGELES: Emmett Babcock, Pomona, California
52. PORTLAND: (Notification Awaited)
53. SAN FRANCISCO: Stanley Bammann, Palo Alto, California
54. SEATTLE-PUGET SOUND: Thomas Quirk Gorton, Mercer Island, Washington

♦

XII WOLVERINE STATE MEMBERSHIP PROMOTION GROUP

REGIONAL CHAIRMAN: Irvin M. Weiss, Grand Rapids, Michigan

55. CENTRAL MICHIGAN: R. K. Martin, Grand Rapids, Michigan
56. DETROIT: Edward J. Kubis, Wyandotte, Michigan
57. GRAND RAPIDS: Orville D. Hoxie, Grand Rapids, Michigan
58. SAGINAW VALLEY: Francis J. Reha, Detroit, Michigan
59. TOLEDO: Julius Bach, Toledo, Ohio.

"TEN PER CENT MINIMUM MORE, TO MAKE YOUR BRANCH MEMBERSHIP SOAR"

AES's Active (Branch) Membership increase goal for the 1960–1961 fiscal year (July 1, 1960–June 30, 1961) has been targetted, with confident hope, by the Executive Board at a minimum 10 per cent over the AES's over-all Branch membership stature at June 30, 1960.

No one but AES's 59 Branches, and immediate membership promotion "maximum effort" by them can, of course, accomplish that AES mission. Consequently, the Society and the Board urge that every AES Branch plan and programme an aggressive campaign now and proceed at once to stimulate earliest possible Branch membership expansion, this meaning growth encompassing election of carefully screened new AES Active Members having 1) a thirst for educational enrichment in the arts and sciences of plating, metal finishing, organic coating and allied arts and equally 2) fitness plus a genuine desire to "belong".

Pursuant to AES Bylaws, the leadership of Branch membership enlargement at Branch level is vested in the Branch First Vice Presidents, and these responsible Branch officers are listed in the Manning Table for the 1960–1961 Branch Membership Expansion Campaign that appears in the adjoining columns.

For purposes of the 1960–1961 drive, each of AES's 59 American, Canadian and Australian Branches has been geographically classified by Campaign Region or Area. And to coordinate and assist the First Vice Presidents of Branches within these Campaign Districts, a member of the 1960–1961 National Membership Committee has been assigned as Regional Chairman. Under the eye of the Executive Board, the national campaign will be spearheaded on a Societywide basis by the National Membership Committee, this year headed by John J. Bunsic of the Southern Tier Branch.

So as to assist Branches in this important mission, each is urged to order reasonable quantities from National Headquarters of any of the following highly considered AES membership promotion visual aids, 1) the effective Branch membership promotion two-color gatefold leaflet, including an Application Blank, 2) the more general booklet, "AES Membership: Its Meaning to YOU", also including an Application Blank and 3) the internationally lauded documentary booklet, "Milestones of AES", recommended by the Public Relations Committee.

A Ten Per Cent Minimum Jump, Will Put *Your* Branch Over the Hump!

Rafael Diaz

RAFAEL DIAZ TO CREATE AES'S 1961 SPEAKERS LIST

Ralph M. McCahan (Hartford Branch), 1960–1961 Chairman of the AES's National Educational Committee has announced the reappointment of Rafael Diaz (Pittsburgh Branch), as Chairman of the Educational Committee's "Subcommittee on the 1961 AES Speakers List". As such, Mr. Diaz of the Westinghouse Electric Company will produce the 1961 Speakers List so vital to the monthly educational sessions programming by the Society's 59 Branches.

Mr. Diaz singlehandedly created the 1960 Speakers List, a worthy feat that earned him Societywide appreciation. His 1960–1961 colleagues will be announced when appointed.

AWARD FOR BEST BRANCH EXPANSION RECORD

AES Branches are grouped into three Divisions according to stature. Division A includes Branches with over 126 members; Division B (70–125 members); Division C (under 70 members).

That Branch making the best membership expansion record in its Division in 1960–1961 AES fiscal year will receive a $50 Award at the Boston Annual Meeting of the Supreme Society in June 1961.

REMINDERS TO AES CHARTERED BRANCHES

The list of your Branch's duly elected Branch Delegates and Alternate Delegates for 1960–1961 is due in the hands of the National Executive Secretary by or before *November 7, 1960*. The tenure (term of office) of these elected Delegates and Alternates is from the FIRST Branch meeting immediately following the 1960 Annual Meeting of the Supreme Society (Los Angeles, July 28, 1960) to the first Branch Meeting immediately following the 1961 Annual Meeting of the Supreme Society (Boston, June 23, 1961) or until their successors are duly elected by your Branch. Your list should be filed on the official form that has been provided to you by National Headquarters, and must be signed by both the Branch President and Branch Secretary.

♦

Your Branch, via its accredited Delegates, has been invited to nominate any qualified member of the Society whom it chooses for consideration for the AES Scientific Achievement Award for 1960–1961. Your choice must be supported by *seven* copies of a statement of your nominee's qualifications. These are all due in the hands of the National Executive Secretary by not later than *October 15, 1960* by the Award's regulations. No nominations will be accepted after that date.

♦

Your Branch, via its accredited Delegates, has been invited to nominate any qualified member of the Society whom it chooses for consideration for AES Honorary Membership. Your choice must be supported by six copies of a statement of qualifications. These are all due in the hands of the National Executive Secretary by not later than *November 15, 1960* by the recorded rules of the Supreme Society. No nominations will be accepted after that date.

♦

Your Branch, through its President of record, will be invited to nominate any member of the Society whom it chooses for consideration for the Charles Henry Proctor Memorial Leadership Award for 1960–1961. More information soon.

♦

If your Branch is among those very few Branches that have delayed to now in appointing a Branch Research Finance Chairman to spearhead your Branch's effort to stimulate Sustaining Membership applications by industrial companies in your area, with the help of the Regional Research Finance Chairman for your territory, please do so promptly and submit his name to the National Executive Secretary's office at earliest possible time for processing.

OPEN INVITATION TO COMPANIES OR AES BRANCHES WISHING TO SPONSOR AN AES PAPER AWARD ON ALUMINUM

Nine annual Paper Awards now exist in American Electroplaters' Society (AES) to recognize, honor and reward those outstanding original technical papers published in AES's PLATING MAGAZINE or TECHNICAL PROCEEDINGS during the fiscal year that are competitively adjudged best by the Society's Paper Award Committee.

With the ninth, namely "Organic Coating Award" (sponsored by the O'Brien Corporation, South Bend, Indiana) just added, the eight others already existing include 1) the "Carl E. Heussner AES Gold Medal Award" (co-sponsored by AES with the United Platers' Foundation, Detroit); 2) "The AES Silver Medal"; 3) "The AES Bronze Medal"; 4) "The George B. Hogaboom Memorial Nickel Plating Award" (AES and its Hartford Branch); 5) "The Robert S. Leather Mechanical Finishing Award" (The Lea Manufacturing Co.); 6) "The Chromium Plating Award" (Nutmeg Chromium Corporation); 7) "The Precious Metal Plating Award of AES" (International Nickel Co.) and the 8) "John J. Hanney Memorial Copper Plating Award" (AES's Grand Rapids Branch and the Metal & Thermit Corporation).

The Executive Board will be happy to consider any Branch or Company invitation to sponsor an annual Paper Award on the "Finishing of Aluminum and its Chemical Treatment". Any Company or Branch wishing to offer an invitation for such sponsorship is cordially invited to notify the National Executive Secretary by not later than November 1, 1960.

FOUNDED 1909

EIGHTH INTERIM MEETING

SUPREME SOCIETY

AMERICAN ELECTROPLATERS' SOCIETY

STATLER HOTEL

HARTFORD, CONNECTICUT

SATURDAY, FEBRUARY 11, 1961

ARRANGEMENTS BY

AES NEW ENGLAND REGIONAL COUNCIL

WITH AES's

BRIDGEPORT BRANCH AS HOST

BRANCH PRESIDENTS
1960-1961

ADELAIDE:
H. F. Watson

ALLENTOWN-READING:
Joseph W. Ross

BALTIMORE-WASHINGTON
Harold W. Scott

BLUE RIDGE:
Bruce E. Wallace

BOSTON:
Hubert H. Foley

BRIDGEPORT:
William Hyatt Jr.

BRITISH COLUMBIA:
John Gordon Smith

BUFFALO:
Harold Shapiro

CAPITOL DISTRICT:
Zygamond Nash

CENTRAL MICHIGAN:
Homer E. Welch

CHICAGO:
Matt Dassinger

CINCINNATI:
Earl Leonhardt

CLEVELAND:
Henry Sedusky

COLUMBUS:
Leslie D. McGraw

DALLAS-FT. WORTH
William L. Aves Jr.

DAYTON:
Byron A. Bowman

DENVER:
Robert D. Martin

DETROIT:
Fred E. Olmstead

GRAND RAPIDS:
Edwin J. Krook

HAMILTON:
C. Ross MacLeod

HARTFORD:
Walter Dyber

HOUSTON:
Harry C. VanWagner

INDIANAPOLIS:
John Holland

KANSAS CITY:
Warren B. Eliot

LANCASTER:
I. Paul Sharretts

LOS ANGELES:
Frank Virgil

LOUISVILLE:
Herbert M. Rembold

MELBOURNE:
Bruce Leslie

MEMPHIS-MIDSOUTH:
Edward L. Lorenzen

MIAMI:
James N. Gibbs Jr.

MILWAUKEE:
Eugene Piellusch

MISSISSIPPI VALLEY:
A. W. Dennhardt

MOHAWK VALLEY:
Robert A. Stewart

MONTREAL:
John Rennie

NEWARK:
John Banta

NEW HAVEN:
Harry R. Taylor

NEW YORK:
Joseph Rembecki

PHILADELPHIA:
James E. Cogan Jr.

PITTSBURGH:
W. Fred Stevens

PHOENIX:
Floyd W. Huhn

PORTLAND:
Information Awaited

PROVIDENCE-ATTLEBORO:
Daniel O. Turner

ROCHESTER:
John J. Cipolla

ROCKFORD:
Harold Ellis

SAGINAW VALLEY:
Raymond E. Gittins

ST. JOSEPH VALLEY:
Theodore D. Shafer

ST. LOUIS
George E. Koderhandt

SAN FRANCISCO:
F. M. Condrott

SEATTLE-PUGET SOUND:
Thomas Presleigh

SOUTHEASTERN:
Myron M. Randman

SOUTHERN TIER:
William Rossiter

SPRINGFIELD:
Alexander R. Salmond

SYDNEY:
William H. Coulson

SYRACUSE:
William M. Robinson

TOLEDO:
Edward Agnew

TORONTO:
Gordon A. Lince

WATERBURY:
William C. Giesker

WESTERN ONTARIO:
James O'Byrne Kelly

WICHITA:
Richard L. Bartholomew

THREE WORKSHOPS FEATURE OF MIDWEST REGIONAL CONFERENCE

Sponsored by the six Branches of the AES Midwest Regional Council—Chicago, Milwaukee, Mississippi Valley, Rockford, St. Joseph Valley and St. Louis—the Second Annual Midwest Regional Conference will be held on Saturday, October 29 at the University of Notre Dame at South Bend, Indiana.

Registration and inspection of exhibits in the Engineering Building lobby are scheduled from 9:15 to 10 a.m. At 10 o'clock, the morning Educational Session will be called to order in the Engineering auditorium. Two speakers are programmed. E. A. Hardy of Travelers Insurance Company will discuss "Plating Room Safety." Robert Geisel, Adolph Plating Company, has as his subject "Plating Personnel."

The speaker at the luncheon in the Mahogany Room of the Morris Inn at the campus will be Rev. James Doll of Notre Dame University, whose subject will be "Germ Free Life."

The afternoon is to be devoted to three Workshop Sessions to start at 2 o'clock. Workshop A, "Mechanical Finishing" will be moderated by National First Vice President Chester G. Borlet. Panel members include Chet Kennedy, Harry Walker, Les Morgan and L. R. Davison.

National Second Vice President Manuel Ben moderates Workshop B, the subject of which is "Plating." The panel members are Don Morris, Jack Winters, John Hunt and Dr. H. J. Wiesner.

Workshop C will be on "Organic Finishing" and National Past President Ralph D. Wysong is the moderator. Panel members for this workshop are Peter Iwema, Barney Case, Joseph Andrus and John Holland.

Frank Marshall is handling advance mail registrations which can be made until October 15. Mr. Marshall's address is 219 So. Orchard Street, Thiensville, Wisconsin.

AES LAPEL BUTTONS

The AES member's handsome silver lapel button can be purchased from your Branch Secretary at $1.38 per button including tax. These, in turn, can be purchased by Branch Secretaries from National Headquarters at that amount. The silver Branch Past President's button can be purchased by Branch Secretaries from the National Office at $1.43 per button including tax.

For cleaning these buttons, here is one expert member's reported method, "Place hot water in which a little washing soda has been dissolved into an aluminum pan or any container with a small piece of aluminum at bottom (concentration: one tablespoonful of soda to one quart of water). Immerse the button so as to touch aluminum, and allow to soak until tarnish disappears. Operation will clean but will not injure the silver."

Dr. Harold J. Wiesner

Dr. D. Gardner Foulke

Raymond L. Mitchell

BROADER RESEARCH PROGRAM PARTICIPATION BEING PUSHED VIA AES BRANCH CAMPAIGN

AES's vital Research Program embodying seven Projects in 1960–1961, and recognized internationally for its values in expanding knowledge of the arts and sciences of plating and metal finishing, is sustained financially by AES not only by a share of each Active Member's annual Per Capita Tax and of each Member-at-Large's annual dues but also, and mainly, by the annual dues of each Sustaining Member company. At fiscal year-end June 30, 1960, AES had some 350 such Sustaining Memberships and these were credited for existence to some 42 of AES's 59 Branches, Chicago with 65 and Detroit with 63 leading the roster. Seventeen AES Branches were responsible for none, an amazing fact.

There is manifest need, according to the Research Committee, to increase the quantity of Sustaining Memberships sizably so that AES can afford an even greater number of worthy Research Projects in American and Canadian universities and foundations without resorting to Research Fund reserves. To attain them, an intensive Sustaining Membership Expansion Campaign is therefore now in progress under the National Research Committee generally and its Vice Chairman for Finance Raymond L. Mitchell (Mitchell-Bate Company, Waterbury, Connecticut) specifically.

The muscles and sinews of the Campaign are AES's 59 Branches, with the generalship of respective Branch campaigns vested in the Branch Research Finance Chairmen now appointed by most Branches with the balance expected promptly to follow suit. Mission is to inspire as many industrial companies located in Branch communities having a dollars and cents interest in advancements in electroplating, metal finishing, organic coating and allied arts to apply for Sustaining Membership. Cost is $100 per membership.

To coordinate and assist Branch Research Finance Chairmen, the Research Committee has now appointed Regional Research Finance Chairmen and these, at the writing, include:

Australia
Bruce Leslie, Melbourne Branch

Canada
Herbert A. Skelton, Toronto Branch

Dixie
George W. Taylor, Southeastern Branch

Empire State
Frank O. Beuckman, Rochester Branch

Keystone State
(To be appointed)

Metropolitan
Robert Duva, Newark Branch

Midwestern
George E. Parisho, Mississippi Valley Branch

New England
Raymond L. Mitchell, Waterbury Branch

Southwestern
Myron E. Browning Jr., Dallas-Fort Worth Branch

Tri-State
(To be appointed)

West Coast
Lawrence M. Henderson, San Francisco Branch

Wolverine State
Edward J. Kubis, Detroit Branch

Every AES Branch is urged to cooperate wholeheartedly in this important 1960–1961 campaign. If a Branch Research Finance Chairman has not yet been appointed, it is urged to appoint a "go-getter" promptly and to notify the National Executive Secretary of the appointment. Each Branch is urged to procure a reasonable quantity from National Headquarters of the AES booklet, "Is Advancement in Electroplating and Metal Finishing Important to Your Company's Future?", and to use them effectively.

Chairman for 1960–1961 of the National Research Committee is Dr. Donald G. Foulke (Sel-Rex Corporation). Vice Chairman for Research is Dr. Harold M. Wiesner (Bendix Corporation). John P. Nichols is Secretary-Treasurer.

George J. Marotta
Education

Louis V. Gagnon
General Chairman

Manson Glover
Finance

Dr. George P. Swift
Administration

AES's COMING PILGRIMAGE TO NEW ENGLAND'S CITADEL OF SCIENCE

BOSTON has been called the "Hub of the Universe", the "Athens of America", the "Literary Mecca of New England", and other complimentary names. It can also be called the "Home of the Boston Bean", the "Playground of Ted Williams and Bob Cousy", the "Smithsonian Institution of America's Genesis" and even the locale of today's version of "Tinker to Evans to Chance", namely "Gagnon to Glover to Swift". But call it what you will, it is still the most historic city in America, a gem in a region that is also a Vacationland Wonder.

More or less within a pitcher's throw of the renowned Boston Common (1634), Burying Ground (1630), Old Corner Book Store (1712), Faneuil Hall (Cradle of Liberty) and Ye Olde Oyster House (1836)—in the modern Statler Hotel of the modern Bay City—American Electroplaters' Society (AES) will conduct its 48th Annual Convention, June 18-23, 1961, with its "young" Boston Branch in a "venerable" metropolis, observing its own Fortieth Anniversary and hosting that National Convention.

Like every AES Convention and every AES enterprise, the prime and never-forgotten goal of that AES Annual Assembly will be enrichment of knowledge in the arts and sciences of electroplating, metal finishing, organic coating and allied arts, and a superior grade educational program is in the making in the chief city of a chief region of our country whose chief product is Education. "Boston", in fact, is not only synonymous with "Culture" but now, and increasingly, also with "Science".

But there are also "off duty" hours at every Convention. Consequently, there will, of course, also be fellowship and fun at the AES's Boston Convention. And aside from the Convention's own bountiful relaxational fare, the AES member and his family will also find that Boston abounds with interesting things to see, to do, to enjoy, ranging—besides capital-grade, memory-making sightseeing—from Pleasure Island, the Boston Symphony Orchestra, the Cambridge Drama Festival and other spectaculars, to Fenway Park baseball, Suffolk Downs racing and Esplanade sailing.

So plan now to attend the AES's Boston Annual Convention. Bring your family. Come principally for education but also be prepared for fellowship and fun. Make it a vacation. View Old Fort Sewell with its Colonial Dungeon, Hawthorne's Birthplace, the Witch House of Salem, Gallows Hill. Visit Rockport Museum, Myles Standish Forest, the Whaling Museum at New Bedford, Northfield's Chateau, Falmouth, Plum Island, Rye Harbor, Sandwich. Make a pilgrimage to Concord—climb the Big Blue—see the Museum of Old Dolls at Chesterfield. Yes, come to the Boston Convention! You'll lament if you don't, exult if you do!

A view of downtown Boston from its magnificent harbor

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Although the majority of present day formulations of nickel plating solutions produce bright nickel deposits which require no buffing, some nickel plating solutions produce deposits which do require buffing.

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If a **satin finish** is required for the final chromium plate, the nickel plate must also have a **satin finish** and this nickel plate is frequently plated over a satin finished base.

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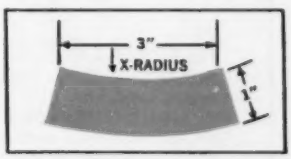

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◀ INDICATE A 1021.

INTERSOCIETY NEWS

RITLAND TO ADDRESS ASTME CONFERENCE

Major General Osmond J. Ritland, Commander, Air Force Ballistic Missile Division, Air Research and Development Command, Los Angeles, will address the American Society of Tool and Manufacturing Engineers at a "California Day" luncheon, Monday, November 14, at the Los Angeles Memorial Sports Arena.

The luncheon is being held in conjunction with the 1960 ASTME Western Engineering Conference and Exhibit at the Sports Arena on November 14 to 18, Harry E. Conrad, executive secretary of ASTME, said.

Honorary Host Committee for the Conference and Exhibit includes A. O. Beckman, president, Beckman Instruments, Inc.; Hugh L. Clary, president, Clary Corp.; Donald W. Douglas Jr., president, Douglas Aircraft Co., Inc.; Robert E. Gross, chairman of the board and chief executive officer, Lockheed Aircraft Corp.; H. Leslie Hoffman, president, Hoffman Electronics Corp.; Dan A. Kimball, president, Aerojet-General Corp.; Charles W. Lee, president, Consolidated Western Steel Division, U. S. Steel Corp.; K. T. Norris, chairman of the board, Norris-Thermador Corp.; Carroll R. West, vice president, Title Insurance and Trust Co.; and Harold W. Wright, general manager, Los Angeles Chamber of Commerce.

General Ritland is a command pilot with more than 9000 flying hours to his credit but for the past few years has had administrative responsibilities for research and development of Air Force ballistic missile weapon systems and related military space programs.

The AFBMD manages and directs, under the highest national priority, the development of Atlas, Titan, Minutemen ICBMs and Thor IRBM. The Division is also engaged in the research and development of military space systems, and conducts certain scientific space programs in cooperation with the National Aeronautics and Space Administration.

The 1960 ASTME Western Exhibit, being held concurrently with the Engineering Conference, is the largest production equipment exposition on the West Coast. More than 250 exhibitors are expected to display over 2000 products. Nearly all the available space at the Sports Arena has been assigned.

♦

BLOW MOLDING SUBJECT OF SPE MEETING

One of the fastest growing segments of the plastics industry—blow molding—will be the topic of a Regional Technical Conference of the Society of Plastics Engineers on November 18 at the Essex House in Newark, New Jersey. Program of the Conference entitled "Blow Molding Comes of Age", sponsored by SPE's Newark Section, encompasses virtually all elements of this subject including history, applications, extrusion techniques, materials technology, machinery, blowing processes, molds and legal aspects.

The technical program of eight papers and a panel of equipment manufacturers has been developed so that the subject matter and sequence of presentation will provide a complete picture of blow molding technology as it exists today.

♦

INSTITUTE OF METAL FINISHING ANNUAL DINNER

The Institute of Metal Finishing will hold this year an annual dinner in conjunction with the annual general meeting and the Hothersall Memorial Lecture on Monday, December 5, 1960 at The Cafe Royal, Regent Street, London.

Although the lecture and business meeting will precede this function it is intended that the dinner itself should be a social event, and the presence of members' ladies and guests will be welcomed.

The annual general meeting will precede the Hothersall Memorial Lecture, to be delivered by Professor J. W. Cuthbertson at 3:30 p.m. The annual dinner will be held at 8 o'clock in the evening.

It is anticipated that the Institute will entertain a number of important guests on this occasion. Members of the Institute who would like to be present are asked to write to the Honorary Secretary, Dr. S. Wernick, Institute of Metal Finishing, 32 Great Ormond Street, London, W. C. 1, England.

♦

OVER 70 PAPERS AT VACUUM SOCIETY SYMPOSIUM

The Seventh National Symposium of the American Vacuum Society will be held October 12, 13 and 14 at Cleveland-Sheraton Hotel, Cleveland, Ohio. Program will include over 70 papers as well as panel discussion on "Pressure Measurements—Their Apparatus and Techniques".

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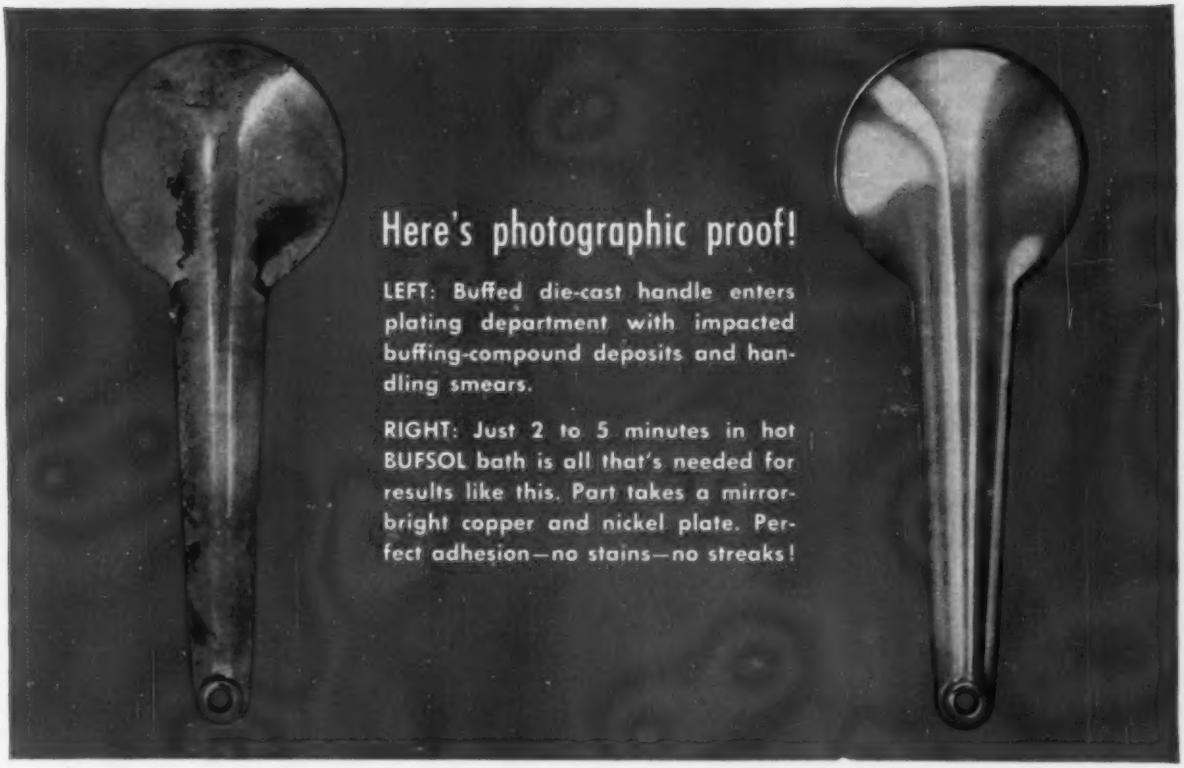
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LEFT: Buffed die-cast handle enters plating department with impacted buffing-compound deposits and handling smears.
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JAPAN'S PLATING INDUSTRY VIEWED BY BLOUNT

A few days after the 1960 AES Convention in Los Angeles (July 24–28, 1960), Ezra A. Blount, editor of *Products Finishing* and a long-time member of AES, departed for Honolulu on the first leg of his visit to plating plants in Hawaii and Japan.

One of the largest plating and finishing plants in Honolulu is that operated by Automotive Service Company reports Mr. Blount. James C. Hardy, president, discussed the finishing business in Honolulu and took his visitor through the plant, established in 1925. It now has facilities for gold, silver, bronze, cadmium, brass, tin, copper, nickel and chromium plating. An anodizing plant supplies anodized (also gold and green dyed) products to the building industry. A hard chrome plating tank nine feet deep makes possible buildup or original plating on large shafts or other parts.

Newest phase of the operation started in May, 1959, and growing rapidly, is an auto bumper repair and exchange service. The firm's truck operators are also salesmen. Mr. Hardy told his visitor that Guy Condrott of A & A Plating, San Francisco, helped initiate the new project. Richard K. Hardy is manager of the plating operation.

On August 4, Mr. Blount arrived in Tokyo. More than 50 leaders of Japan's plating industry from Tokyo, Nagoya and Osaka greeted Mr. Blount.

The following day Mr. Blount visited Fukui Denka Kogyo Co., Ltd., which plant has facilities for semi-automatic cleaning and barrel plating, semi-automatic copper, bright nickel, and chromium plating, and barrel tumbling. The cleaning machine automatically takes the PVC barrels (39 by 12 in.) through cleaning, pickling, cyanide and rinse. Semi-automatic machines then plate the parts with zinc, cadmium, copper, nickel, brass and a copper-zinc alloy (imitation gold).

Visitor Blount found copper, nickel and chromium plating being carried on in another building. Many solid PVC tanks, PVC-lined tanks, and rubber-lined tanks are in use. Polyethylene rack insulation is common. Tank exhausts are adequate and well designed. A PVC washing and neutralizing tower removes nitric acid fumes (from brass bright dipping) from the air.

(Top left) Ezra A. Blount was welcomed at the Tokyo Airport by about 50 leading Japanese electroplaters when he arrived in their country early in August. T. Tohei, right foreground, president of Tohei Plating Co., was official spokesman. (Right top) Examining an automatic cleaning and pickling machine at the Fukui Denka Kogyo Co. plant. Left to right, M. Fukui, president; T. Fujino, consultant; Ezra A. Blount; S. Omura, chief director and Prof. Dr. S. Tajima, Tokyo Metropolitan University. (Lower left) Barrel plating at Fukui Denka Kogyo Co. (Lower right) Semi-automatic rotary copper plating machine in operation at Continental Plating Co. T. Nakanishi, production foreman, is at extreme right.

Standard plating solutions are employed, Mr. Blount learned. Brighteners for copper, nickel, zinc and cadmium are produced in Tokyo. Most of the tanks, machines and electrical power equipment in this plant were made by Seisakusho Co., Nagoya. Over 100 employes work one shift, of 55 hours per week. Control laboratory facilities are excellent.

The next shop Mr. Blount visited was Continental Plating Company. He reports, its principal operations are copper, nickel and chromium plating of steel parts, parts, die castings, and aluminum parts. Vapor degreasing, electrolytic cleaning, and conventional plating solutions are employed. An organic brightener is used in the Watts nickel solution. Racks insulation here is plastisol. A motor-generator supplies current for plating. Two rotary semi-automatic plating machines deposit copper and nickel, respectively. Plating machines like this one seem to be popular in Japan. This plant has specialized in hub cap plating. It has a full-automatic copper, nickel and chromium plating machine made by Murata Industrial Co. of Kobe.

Aikoku Electroplating Industry Co., Ltd. was Mr. Blount's third visit of a busy day. This company hard chromium plates large rolls for the paper industry; porous chromium plates diesel and other engine cylinders; and chromium plates axles, journals and other large parts. Hard copper plating and iron plating are also specialties of this plant.

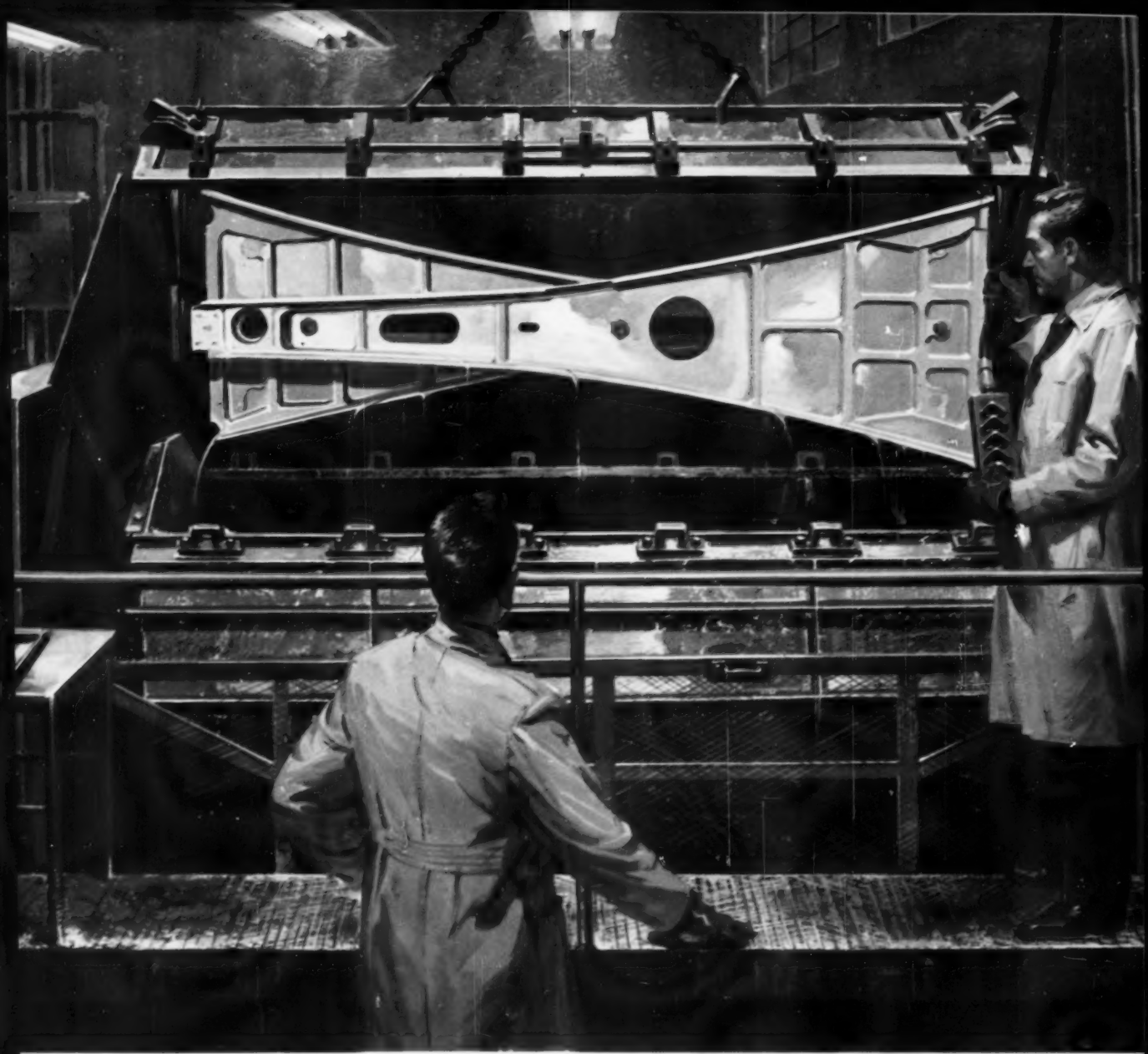
The plant operates three shifts and has 80 employes. A large laboratory does experimental work and process control. Several large buildings enclosed in a "compound" comprise this plant.

Mr. Blount also visited Tohei Plating Co. This shop specializes in gold plating, but also does copper, nickel, silver, brass and chromium plating plus electrostatic (and manual) painting and lacquering.

The main plant (one of four) includes several buildings and the various operations are grouped logically. The buffing department occupies one building; copper, nickel and silver plating are on the first floor of one building; gold plating is on the second floor; painting and infrared baking are in another building. The gold plating department has cleaning and pretreatment tanks plus two automatic gold plating tanks of 75 gallons capacity each. The tanks are air agitated and the solution is circulated, and the cathode rod oscillates to provide further part movement. Each tank is complete with its own rectifier and controls. Mr. Blount found laboratory control facilities to be first rate.

INDICATE A 1036 ▶

(Left) Portions of the buffing operation at Tohei Plating Co., Ltd. (Center) Mr. Blount has just been shown by Yoshio Hirasaiva, president of Aikoku Electroplating Industry, Ltd., a large hard chromium plated roll processed to a mirror finish. (Right) S. Makiguchi, production head, exhibits automatic gold plating machine, designed by him, at Tohei Plating Co.



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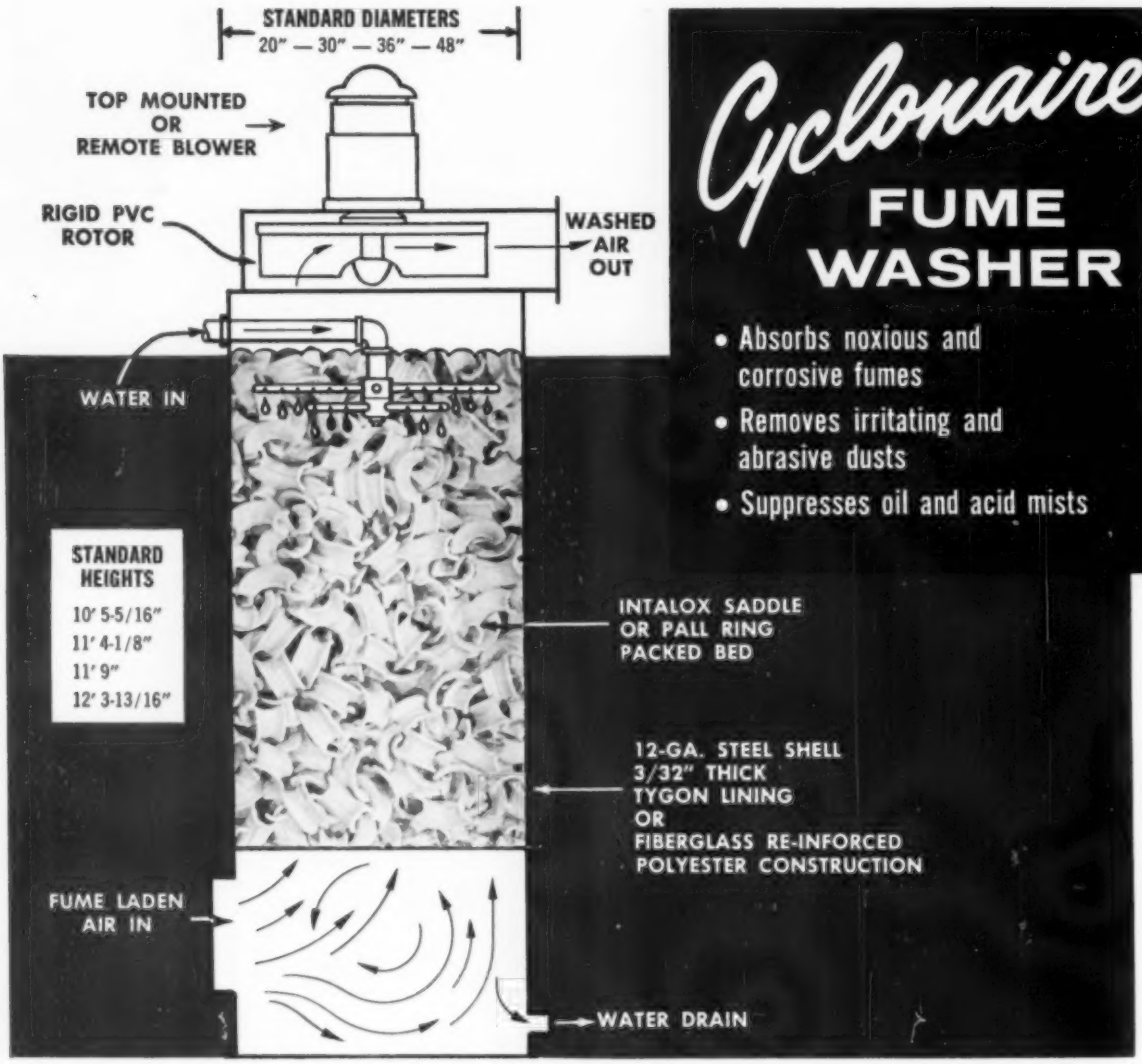

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VT-77	7 cu. ft.	31"	17"	22½"
VT-712	12 cu. ft.	35"	25"	30⅜"
VT-717	17 cu. ft.	47"	25"	30⅜"

New VT-72 Vibrasheen being unloaded into optional hoist-pan. Note convenient height of controls.

ANOTHER REPORT FROM THE ALMCO ALBUM OF NEW PRODUCTS

IT'S A FACT! With the seven (7) new ALMCO Vibratory Machines, you can expect finishing time cycles 10 to 100 times faster than with standard horizontal barrel finishing equipment. It's a significant production break-through, made possible by creating constant vibratory motion to activate the entire mass of media and parts in the finishing container, as compared to only 20% activation with conventional barrel finishing methods.

The uniform vibratory motion of the media in recessed areas, blind holes and small I.D. dimensions make it possible to obtain optimum results on a multitude of applicable parts with intricate configurations that can not be completely processed in standard horizontal barrel machines.

What's more, this amazing metal finishing machine only requires 50% of the floor space that is taken up by any other machine of this type with a similar capacity. Time and motion is at the absolute minimum with all convenient operating conditions.

Tub features. Holds a 2½ cu. ft. load of parts and media. Equipped with vibrating mechanism adjustable for impact range of from 600 to 2550 lbs.; has a vibration frequency of 3380 rpm with variable drive optional. Pivots through 180° arc. Lined with tough ⅜" plastisol. Quick-acting cam-lock drain door facilitates flushing of tub.

Investigate today, the ALMCO *Vibra-Sheen way!*

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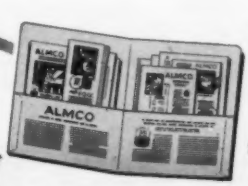

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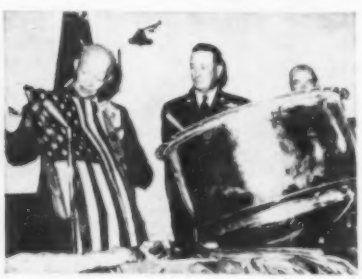
INDUSTRY NEWS

SPACE CAPSULES PLATED WITH SEL-REX BRIGHT GOLD

The first man-made objects to be recovered from outer space orbits—the capsules from the U. S. missile satellites Discoverer XIII and XIV—were plated with Sel-Rex Bright Gold by Philadelphia Rust-Proof Co., Inc. under sub-contract from General Electric Co.

According to Philadelphia Rust-Proof engineers, the Discoverer capsules were plated with Sel-Rex bright gold to provide maximum heat reflectivity and emissivity, as protection to delicate instrumentation against the temperature extremes of outer space travel and re-entry.

Morris M. Messing, president of Sel-Rex Corporation, Nutley, New Jersey, reports his company's precious metal electroplating processes are called for in the original specifications of numerous sophisticated Space Age devices and equipment. Among others, the U. S. IGY Earth Satellites, the Atlas, Thor and other missiles, the IBM SAGE Computer and the UNIVAC Solid State Computers, all are known to contain equipment, contacts and circuitry plated with the patented processes.



The "lucky 13" Discoverer satellite capsule electroplated with the patented Sel-Rex bright gold process, is first man-built object retrieved from space orbit. President Eisenhower holds an American flag which was in the capsule during the flight. Behind the capsule are General Thomas D. White, Air Force chief (left) and Colonel Charles G. Mathison, who directed the "capsule chase."

♦

INCAR MOVES TO NEW CLEVELAND ADDRESS

Incar, Incorporated has moved to 2097 Columbus Road, Cleveland, Ohio, where they now have new and enlarged plant facilities. Included are new service, organic, research and instrument laboratories.

♦

NEW ABRASIVE COMPANY FORMED

Benjamin F. Post, former research and development engineer in the abrasives field, has announced the formation of Custom Abrasive Products Co., Inc., with offices at 373 West State Street, Trenton, New Jersey.

Created for sales and technical services to the metal finishing trades in the Middle Atlantic and New England states, the company will specialize in barrel and vibratory finishing media and compounds as well as pressure blasting abrasives.

Capco will not sell equipment, Mr. Post said, but will concentrate on applying knowledge of the limitations, advantages and applications of various media and compounds to the fields of metal cleaning, coloring, preparation for plating and finishing of castings.

BRITISH FIRM LICENSED BY TECHNIC, INC.

Silvercrown, Ltd., London, England, has been licensed to manufacture and sell the complete line of Technic, Inc. precious metal plating products.

Silvercrown has exclusive rights to manufacture Technic products in England for sale in England, the Commonwealth, except for Canada, and throughout Europe.

In addition, G. Schmerling, managing director of Silvercrown, has announced that Dr. Ing. Max Schloetter, headquartered in Geislingen/Steige, has been sublicensed to sell in Germany the Technic products made in England.

The British firm is one of Europe's

Arrangements for Silvercrown, Ltd., London, England, to manufacture and sell Technic solutions for precious metal plating were made during a recent trip abroad by A. M. Weisberg (right), vice president of the Providence, R. I., firm. Shown at the International Metal Finishing Conference in England are (left to right) Adrian Walmsley, northern representative for Silvercrown and area chairman of the Institute of Metal Finishing; R. Clegg, sales manager of Silvercrown; G. Schmerling, managing director of the British firm; and Mr. Weisberg.

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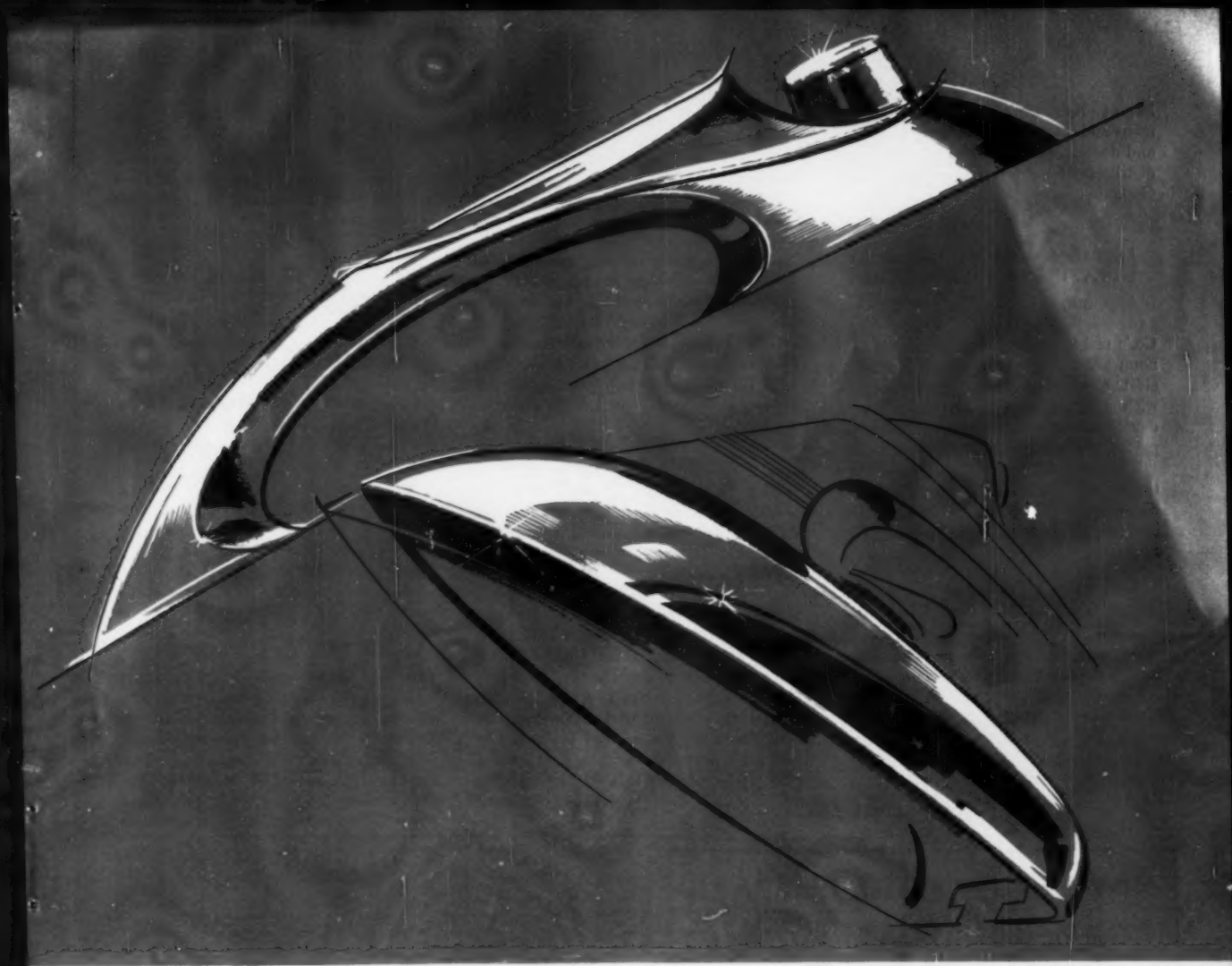

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largest producers of electroplating equipment and materials for industrial, defense, and decorative use. Dr. Schloetter's firm distributes its products through most of Germany.

♦

METAL & THERMIT ADDS TO PLATING PRODUCTS LINE

Appointment of Metal & Thermit Corp. as distributor for The International Nickel Co.'s nickel anode products has been announced. M&T is a pioneer in the field of electroplating products and processes, with a background dating back to the development of the original chromium plating process in the 1920's.

The nickel anodes are being supplied in the rolled carbon, depolarized and cast nickel forms. They are stocked by M&T in Chicago, Detroit, and Rahway, New Jersey.

♦

ENTHONE NAMED DISTRIBUTOR FOR TECHNIC PRODUCTS

Enthone, Inc. has been named distributor for the full line of precious metal plating products of Technic, Inc., Frank K. Smith, president of Technic, recently announced.

Technic, of Cranston, R. I., is one of the largest producers and sellers of solutions for gold, platinum, rhodium and palladium plating.

The New Haven-based Enthone firm, subsidiary of American Smelting and Refining Co., is a leading producer of metal finishing chemicals and electroplating equipment. Addition of the Technic line of products marks the company's entry into the precious metals plating field. The new arrangement offers customers of Technic and Enthone the combined service facilities of the scientific and engineering staffs of both companies.

The Technic staff will continue to serve its own customers and will work directly with Enthone personnel. The agreement already is in effect.

♦

COWLES PURCHASES POOR'S PROMAT DIVISION

In a joint statement Max Ruppert, president of Poor & Co., Chicago manufacturer of railroad equipment and supplies, and R. F. Huntley, president of Cowles Chemical Co., Cleveland, announce the purchase by Cowles of the Promat Division of Poor & Co.

The purchase of the Promat Division is a natural expansion for Cowles metal finishing products department, according to Mr. Huntley. The two lines complement each other without duplication and find use in the same metal trades. The obvious marketing advantage and other tangible benefits in this acquisition were described as being most profitable to Cowles.

For the time being, Cowles will continue to manufacture Promat products at Poor's plant in Waukegan, Illinois, and the sales and servicing of these products will continue to be handled by the Promat organization.

♦

PRECISION CASTINGS HOSTS BANQUET FOR SUPPLIERS

Precision Castings Co., Cleveland Division of Precasco Corp., 12600 Berea Road, sponsored an innovation in the industry on June 14, by paying tribute to 63 key suppliers of services and raw materials by providing a social meeting and banquet at the Hotel Sheraton-Cleveland, Cleveland, Ohio.

The purpose of this meeting was voiced by William N. Brammer, vice president-marketing, by inviting suppliers of precision castings to become enthusiastic members of the company's team. Mr. Brammer stated that this dinner meeting was merely the firm's way of telling its suppliers about the aggressive progress it is making, all aimed at leading the way into a new era of die casting.

Mr. Brammer asked for continued spirited cooperation from the various segments of the industries represented to provide the proper raw materials and equipment to attain the enthusiastic outlook of the aluminum and zinc die casting industry. "There are still many unscratched

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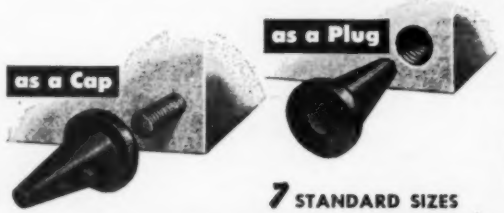

7 STANDARD SIZES

	A	B	C	D	E	F	G
TO PLUG HOLE SIZE	1/8-3/16	3/16-1/4	1/4-5/16	5/16-1/2	1/2-5/8	9/16-11/16	5/8-3/4
TO CAP STUD SIZE	3/32-5/32	5/32-3/16	3/16-1/4	1/4-5/16	5/16-3/8	3/8-7/16	5/16-1/2

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fields of application for die castings. The trend of conversion of many conventional components to light metal is accelerating, as is being demonstrated by the automobile industry. The die casting industry is producing larger and larger parts by their processes", Mr. Brammer said.

A. D. Weigolt, vice president and general manager of Precision Castings, often referred to as "The Dean of the Die Casting Industry" welcomed those present and spoke briefly on the fine cooperation between the company and its suppliers. Mr. Weigolt briefly reviewed die casting history, with which he has had personal contact for the past 33 years, and spoke enthusiastically of the future growth of the firm.

♦

OUTDOOR EXPOSURE CONFIRMS LABORATORY TESTS

Results of outdoor exposure tests over the past year on thousands of chromium plated sample panels here and in the seashore atmosphere at Kure Beach, N. C., have confirmed the earlier excellent results with accelerated laboratory tests on corrosion resistance of thicker chromium plate over bright nickel, according to Dr. Edgar J. Seyb, research supervisor at Metal & Thermit Corp.'s electrochemical laboratory in Detroit.

The outdoor corrosion tests show that when applied over bright nickel superior protection is provided by thicker chromium such as crackfree and duplex chromium. The fact that these outdoor tests agree with the earlier success in the two new accelerated corrosion tests widely used in the automotive industry strongly indicates that greatly improved corrosion resistant chrome finishes are reaching the public today.

These two accelerated tests which were used to screen the new finishes were the CASS test (copper-accelerated acetic acid salt spray) and the Corrodkote test, both developed as a result of a research project sponsored by the American Electroplaters' Society and used by General Motors, Ford and Chrysler.

Dr. Edgar J. Seyb (right), research supervisor at Metal & Thermit Corp.'s research laboratory, examines outdoor exposure-tested chromium-plated sample panels.

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IONIC APPOINTS CANADIAN AND PENNSYLVANIA DISTRIBUTORS

The appointment of Paasche Airbrush (Canada) Limited, as Canadian distributor for Ionic Electrostatic Corp. has been announced by John Sedlacsik Jr., president. Paasche Airbrush maintains offices at 864 Pape Avenue, Toronto, and 852 Notre Dame Street West, Montreal.

The major item to be handled by Paasche will be the recently announced Ionic Model 10 electrostatic hand spray gun with the new electro-centrifugal dispersion technique.

Ionic is broadening its program of regional distributorships to provide faster sales and service and Industrial Finishing Systems, Inc., 141 East Glenside Avenue, Glenside, Pa. has been appointed exclusive representatives for the State of Pennsylvania.

E. C. ELECTROPLATING COMPLETES NEW ADDITION

E. C. Electroplating, Inc. of Garfield, New Jersey, has recently completed a new addition to its precious metal plating department. The principal operations of this facility will be to more effectively service the electronic industry. This new 5000-sq ft unit will house production, laboratory and inspection facilities. Isidore Friedman, technical director, heads the staff of this department.

♦

SELECTRONS, LTD., FORMED TO PRODUCE PLATING EQUIPMENT

Selectrons, Ltd., New York City, has been organized to build and market plating equipment. The company is introducing a new line of power packs, styluses, and electrolytes, designed for controlled deposits of many metals—even alloys—on almost any conductive basis material. A complete national sales and service organization for this process is presently being established.

♦

DUPONT EXPANDS SULFURIC ACID PLANT

The DuPont Co. has announced plans for a major expansion and modernization of its sulfuric acid plant at Wurtland, Ky. The company also announced it will establish a new bulk acid terminal near New Cumberland, W. Va., to provide service for customers in the Eastern Ohio and Pittsburgh areas.

Upon completion late next year, the Wurtland plant will become one of DuPont's largest acid plants.

The new bulk acid terminal will be located on a 70-acre site along the Ohio River about six miles downstream from East Liverpool, Ohio. Docking and liquid terminal facilities will be installed to handle acid shipped by barge from the new Wurtland plant.

♦

HAMPDEN CHEMICAL ADDS TO LINE OF PRODUCTS

Hampden Chemical and Equipment Co., 2751 Juniata Street, Philadelphia 37, Pa., is now representing a considerable number of additional firms in their area, which in most cases includes eastern Pennsylvania, southern New Jersey including Trenton, Delaware and Maryland.

The appointments include The Manderscheid Co. of Chicago, Nuodex Products Co. of Elizabeth, Lion Mills of Hartford, D & M Products, Inc. of Pasadena and The Dole Valve Co.

Kenneth Clayton and Otto Kuhn will personally service the territory.

♦

CORTEZ CHEMICALS BUILDS NEW PHOENIX PLANT

A new warehouse and manufacturing facilities has been constructed at 734 E. Southern Pacific Drive, Phoenix, for the Cortez Chemicals Co. The building, 140 by 50 feet, is a steel frame structure with steel siding—and will add 7000 square feet of space for the production of agricultural specialties, industrial cleaners and compounds, water and sewage-treating chemicals, and chemical specialties for the electronics industry.

Cortez, a division of Arizona Fertilizer and Chemical Co., is engaged in a $200,000 expansion program. Immediately upon completion of its new warehouse and manufacturing facilities, Cortez will begin construction of the second unit in its expansion program—a new headquarters building which will contain office space and research and development laboratories.

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INDUSTRY NEWS BRIEFS

GOLD COATING PROTECTS SPACE VEHICLE

"Steering jets" built for advanced space vehicles will be coated with gold to fight off cosmic bombardments.

The jets, called thrust controllers, manufactured by Bendix-Pacific division of The Bendix Corp., are being plated with gold because of its reflectivity and density properties—not for glamor.

The hand-sized electro-pneumatic controllers, first developed by the company for the Discoverer satellite series, keep space vehicles from tumbling and spinning in flight by automatically providing opposing thrusts of gas, Bendix engineers explained.

The 99.8 per cent pure gold plating is 40 millionth of an inch thick. This coating will reflect 95 per cent of all energy radiation which might strike an orbiting vehicle's surface, Bendix-Pacific engineers say.

During the coating process, the controller is first sprayed with a thin coat of epoxy, a plastic which helps bond the gold to the metal device. Solid gold and the controller are then placed in a near-vacuum chamber, and the gold is heated to 4712F. At that temperature, the gold vaporizes and spreads throughout the chamber to thoroughly plate the controller. Later, the unit is baked for 30 minutes in a special oven to complete the coating treatment.

♦

SOBIN DISTRIBUTOR FOR SHAWINIGAN; BRUMBERGER APPOINTED

The appointment of Irving M. Sobin Chemical Co., Inc. of Boston as sole distributor of liquid and solid sodium cyanide in the United States for Shawinigan Chemicals Ltd. of Montreal, has been announced.

Coincident with the announcement, Sobin has appointed R. C. Brumberger, formerly of Nuodex Products Co. and well known in the plating trade, who will concentrate his efforts toward national domestic distribution of the output of Shawinigan's cyanide plant. Mr. Brumberger, a member of the Newark Branch AES, will have headquarters in Short Hills, New Jersey, and will handle other items of the Sobin line for the metal finishing industry.

♦

BUREAU OF MINES NICKEL-COBALT RESEARCH ANNOUNCED

Development of processes for recovering nickel and cobalt from high-temperature alloy scrap and for obtaining high-purity nickel and cobalt from laterite ores are primary aims of Bureau of Mines research on these metals during the fiscal year that began July 1, 1960, the Department of the Interior announced.

Work on these problems is now underway at Bureau Research Centers in Salt Lake City, Utah; College Park, Md.; and Minneapolis, Minn. A process combining solvent extraction and electrolysis is one of several approaches being taken.

♦

ACOUSTICA ESTABLISHES EASTERN SHIPPING POINT

A servicing and shipping center for Acoustica ultrasonic cleaning equipment has been established at 463 Old Country Road, Westbury, Long Island, N. Y. Although Acoustica ultrasonic cleaning equipment is manufactured on the West Coast, the new location at Westbury will be the shipping point for the eastern seaboard.

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Rockwell "F" Scale	75	66
Ductility	4 bends on itself	2 bends on itself

(Thickness of copper specimens tested was 0.033")

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PATENT ABSTRACTS

DR. D. GARDNER FOULKE

SEL-REX CORPORATION

Nutley, New Jersey

Copies of patents may be obtained by writing to Commissioner of Patents, Washington, D. C. Price 25 cents each.

2,932,590, 4/12/60—INDIUM OXIDE COATINGS—R. Barrett, et al., assignors to The Battelle Development Corp., Columbus, Ohio.

Thermally evaporate indium on a substrate at a slow rate in the presence of residual air pressure in the evacuated system.

9 claims.

2,932,592, 4/12/60—PRODUCING THIN FILMS—A. Cameron, Oak Ridge, Tenn.

To produce molecular layers of the reaction product of a metal vapor and O_2S, Se and Te, expose the article to the metal and non-metal vapors in an evacuated system.

20 claims, figure.

2,932,609, 4/12/60—ELECTROFORMING—N. Pierce, assignor to Bell Telephone Laboratories, Inc., New York, N. Y.

Wet the surface of a non-conducting mandrel with graphite, then with graphite containing Fe, Zn and Cd and immerse in a copper salt solution to deposit on said mandrel a coating of copper. Finally electroform on the copper.

5 claims.

2,932,610, 4/12/60—BRIGHTENER—R. Robinson, assignor to John A. Manning Paper Co., Inc., Troy, N. Y.

The use of a dried, dehydrated okra pod extract as an electroplating brightener is claimed.

4 claims.

2,932,885, 4/19/60—ZIRCONIUM-CLAD STEEL PLATE—T. Watson, assignor to Lukens Steel Co., Coatesville, Pa.

First plate zirconium sheet with iron or nickel, then join by heat and pressure in an inert gas atmosphere.

2 claims, figure.

2,932,887, 4/19/60—BONDING TO ZIRCONIUM—F. McCuaig and R. Misch, assignors to U.S.A. (AEC).

A brazing alloy to join materials to zirconium consists of 6–9 per cent Ni, 6–9 per cent of one of Cr, Mo, W and 0–7.5 per cetn Fe, the rest zirconium.

4 claims.

2,933,212, 4/19/60—CONVEYOR—P. Hauck, assignor to Hanson-Van Winkle-Munning Co., Matawan, N. J.

A material handling apparatus having a plurality of work stations in a row is described.

15 claims, figure.

2,933,415, 4/19/60—NICKEL COATED IRON PARTICLES—H. Homer and J. Whitacre, assignors to The Commonwealth Engineering Co., Dayton, Ohio.

Iron particles nickel-coated by gas plating are described.

2 claims, figure.

2,933,422, 4/19/60—COATING WITH COPPER-TELLURIUM COMPOUND—Walter A. Mason, Minneapolis, Minn.

A copper-tellurate solution for coloring and coating metallic surfaces is described as containing a water-soluble cupric salt, an oxygen acid tellurium salt and an accelerator such as vanadate, molybdate, chromate or manganate and an aqueous acidic solvent.

6 claims.

2,933,425, 4/19/60—HEATING TIN STRIP—F. Hess, assignor to Selas Corp. of America, Dresher, Pa.

Tin coated strip is heated by radiant means to raise to a temperature just below the melting point of tin after which superheated steam is discharged against the strip to melt the tin.

3 claims, figure.

2,933,437, 4/19/60—LAPPING METHOD—O. Loosme, assignor to Bell Telephone Laboratories, Inc., New York, N. Y.

A chemical lapping method for a metal and non-metal composite consists of treating with a chemical solution which reacts with the metal to yield a compound softer than the metal and continually abrading with a material too soft to scuff the metal or non-metal composite.

8 claims, figure.

2,933,438, 4/19/60—STRIP PLATING APPARATUS—L. Lancy, Ellwood City, Pa.

An apparatus and method is claimed wherein the content of the solution carried out by the strip is conditioned with respect to cations and anions.

18 claims, figure.

2,933,443, 4/19/60—TANK—C. Parsons, assignor to Fansteel Metallurgical Corp., New York.

A tantalum electroforming tank fitted with a tantalum shaft, etc. is described.

5 claims, figure.

2,934,478, 4/26/60—PLATING WITH ALUMINUM—W. Schickner, assignor to U.S.A. (AEC).

Immerse the dry article in a fatty acid of at least 11 carbons, then in an organic solvent solution containing aluminum and plate.

10 claims.

2,934,479, 4/26/60—PRINTED CIRCUITS—L. Deer, assignor to U.S.A. (Navy).

A process for masking and plating printed circuit boards is claimed.

2 claims, figure.

2,934,480, 4/26/60—COATINGS ON TITANIUM—G. Slomin, assignor to Rohr Aircraft Corp., Chula Vista, California.

A method for anodizing titanium sheet consists of passing a current through the sheet in a bath of sodium fluoride and an alkali metal hydroxide at 35–40 bolts. A blue, non-porous, adherent oxide is formed which is then heated at 400F.

3 claims.

2,935,419, 5/3/60—METHOD OF ALUMINIZATION—D. Mitchell, assignor to American Mollerizing Corp., Beverly Hills, California.

The method consists of passing the aluminum through a molten halide bath, thence directly through the molten aluminum.

11 claims, figure.

2,935,420, 5/3/60—COATING METALS—H. Linden, Beverly Hills, Calif.

Place a coating substance on at least a portion of the surface of a packed bed of finely divided heat-resistant granular solids and coating substance also floating on the surface of the bed. Heating the bed melts the coating material and strip is pulled through the molten coating metal and through the bed.

24 claims, figure.

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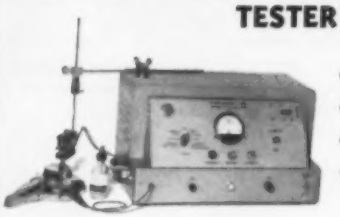

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2,935,421, 5/3/60—COATING WITH MAGNESIUM—D. Chisholm, assignor to The Dow Chemical Co., Midland, Mich.

Steel can be coated with magnesium by passing $TiCl_4$ through a molten salt flux so that the $TiCl_4$ contacts the steel while in molten magnesium.

5 claims.

2,935,422, 5/3/60—CORROSION-PREVENTING COATINGS—A. Chester and J. Stella, assignors to Poor & Company, Chicago, Illinois.

Apply to an article a vitreous enamel and a predominantly thermoplastic polyvinyl resin containing tetraalkylortho silicate which can be hydrolyzed to silica and enhance the resinous coating-enamel bond.

11 claims, figure.

2,935,423, 5/3/60—PROTECTIVE COATING FOR MAGNESIUM—W. Kapfer and M. Kronstein, assignors to U.S.A. (Navy).

Clean the magnesium surface, treat in a solution containing 50–95 parts of $Na_2P_2O_7$, 1–5 parts of NaF, 4–40 parts of a metallic salt ($CdSO_4$, $CuSO_4$, $Cr_2(SO_4)_3$, $NiSO_4$, $Cd(CN)_2$, $Cr(NO_2)_3$ and $Al(NO_2)_3$), rinse and dry. Then immerse in a 5–40 per cent aqueous solution of iron phosphate, ammonium vanadite or sodium dichromate.

3 claims.

2,935,425, 5/3/60—ELECTROLESS NICKEL—G. Gutzeit, P. Talmey and W. Lee, assignors to General American Transportation Corp., Chicago, Ill.

The use of a first (malic acid and salts thereof) chelating agent and a second (lactic acid and its salts) chelating agent and an exaltant consisting of succinic acid and its salts in a hypophosphite electroless nickel bath is described.

29 claims.

2,935,431, 5/3/60—COATING TITANIUM—E. Shaw and N. M. Ness, assignors to I.C.I., Ltd., England.

Treat the titanium with an aqueous acidic solution of ferric oxalate and fluoride ions.

7 claims.

2,935,432, 5/3/60—METAL TREATMENT—L. Schuster, H. Whitenight and W. Jung, Jr., assignors to Reilly-Whiteman-Walton Company, Montgomery County, Pa. and Kelsey-Hayes, Company Detroit, Mich.

A metal coating preparation is described as consisting of hydrophilic organic compound having 12–30 carbons, up to 90 per cent of a non-volatile organic metal lubricant, 1–15 per cent water and 2.5 to 25 per cent of phosphoric and phosphorous acids.

18 claims.

2,935,454, 5/3/60—ELECTRODEPOSITION OF TITANIUM—Shin-Ichi Tokumoto, Tokyo, Japan.

Pass the object through a mixture of 6 to 13 parts (molar ratio) of BaBr, 10–20 parts of $MgBr_2$ and 15 parts of Na Br admixed with titanium bromides and impressing an intermittent current of a frequency of at least 100.

5 claims, figure.

2,935,455, 5/3/60—ELECTROPOLISHING—F. Swagler, assignor to Poor & Company, Chicago, Illinois.

A phosphoric acid-oxyalkylene compound bath is described.

14 claims.

2,935,989, 5/10/60—PROCESSING APPARATUS—Peter Arnold, assignor to Hanson-Van Winkle-Munning Co., Matawan, N. J.

A plating conveyor and transfer device is described.

10 claims, figure.

2,936,254, 5/10/60—CONVERSION COATING BATHS FOR ALUMINUM—N. Newhard and D. Dollman, assignors to Amchem Products, Inc., Ambler, Pa.

A bath for coating aluminum containing fluorides, chromic acid and phosphate is designed to precipitate K_2NaAlF_6.

6 claims.

2,936,270, 5/10/60—CLEANING TITANIUM—H. Webster and R. Devane, assignors to Kolene Corp., Detroit, Michigan.

A molten salt bath method of descaling titanium is claimed.

See also **2,936,278,** describing an apparatus (1 claim) for cleaning strip in a salt bath.

4 claims.

2,937,108, 5/17/60—TINNING STRIP STEEL—T. Toye, assignor to British Iron and Steel Research Association, London, England.

A method of tinning one side, then the other, of strip steel from a roller to give differing thicknesses on either side of the strip.

1 claim, figure.

2,937,111, 5/17/60—REMOVING ORGANIC COATINGS—G. Leithauser, assignor to General Motors Corp., Detroit, Mich.

Synthetic resin coatings can be removed in a solution of 93 to 98 parts of phenol or cresol, 1.5 to 5.0 parts of phosphoric acid and 0.5 to 2.0 parts of a wetting agent.

10 claims.

2,937,978, 5/24/60—NICKEL PLATING—W. Strauss, et al. assignors to Dehydag, Dusseldorf, Germany.

The use of X—R—SO_3H where X = halogen, cyanide and thiocyanate and R is an alkyl of 2-4 carbons and Z—S—R—SO_3H where Z is a carbon carrying N, O or S atoms and R an alkyl of 3-4 carbons in nickel baths to give bright deposits is claimed.

12 claims

2,938,774, 5/31/60—CHEMICAL MILLING—L. W. Bahe, assignor to Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

A bath of phosphorus oxychloride in a nonaqueous solvent is used to etch ferrous metals by bubbling chloride, bromine or iodine through the solvent.

8 claims.

2,938,840, 5/31/60—CADMIUM PLATING—S. W. Strauss and Peppino N. Vlannes, Washington, D. C.

A bath for plating cadmium consists of methanol and cadmium acetate at 70 to 20C.

3 claims.

2,938,842, 5/31/60—DEPOSITION OF FE—CR ALLOY—H. Nitto, assignor to Yawata Iron & Steel Co., Tokyo, Japan.

The bath consists of 0.5 mol/l of chromic sulfate, 4.6 mol/l of urea, 3 mol/l of $(NH_4)_2SO_4$, 0.05 mol/l of $FeSO_4$, 0.1 mol/l HCOOH, in water. Maintain the *p*H at 1.6, the temperature at 25C, and plate at 30 asf.

2 claims.

2,938,850, 5/31/60—WORK HOLDER FOR ELECTROPLATING—H. Nali, Rockford, Ill.

A plating rack is described in 10 claims and a figure.

2,939,772, 6/7/60—ETCHING ALUMINUM—K. W. Newman, et al., assignors to Turco Products, Inc., Los Angeles, Calif.

The addition of a compound of Cr, Ti, Va and Mn in the amount of 0.1 per cent to 10 per cent of the NaOH of an aluminum etching bath is described.

18 claims.

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2,939,823, 6/7/60—ELECTROREFINING TITANIUM—M. J. Rand, assignor to The New Jersey Zinc Co., New York, N. Y.
A fused salt refining bath is described.
5 claims, figure.

2,939,824, 6/7/60—PRODUCTION OF ALUMINUM—E. W. Greenfield, assignor to Kaiser Aluminum & Chemical Corp., Oakland, Calif.
Impressment of a periodically varying voltage on a fused salt cell is claimed to suppress the anode effect.
10 claims, figure.

2,939,825, 6/7/60—SHARPENING ELECTROCONDUCTIVE MATERIALS—C. Faust and J. Clifford, assignors to The Cleveland Twist Drill Co., Cleveland, Ohio.
An electro-sharpening method wherein the device to be sharpened is made the anode in an electrolyte is described.
12 claims, figure.

2,939,826, 6/7/60—METHOD OF CLEANING—G. L. Gulick, 33 Union Avenue, Bala-Cynwyd, Pa.
To clean a ferrous object, immerse in an alkaline solution (0.3–30 per cent) containing a tertiary amine (0.5–47 per cent by weight) and subject to a 400 cycle frequence currynt.
1 claim.

2,939,828, 6/7/60—ELECTROPLATING APPARATUS—J. Hausner, assignor to K. Kaempfer, Barrington, Ill.

The use of an oscillator in a plating set-up is described.
2 claims, figure.

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2,940,917, 6/14/60—ANODE—J. R. Dyson, assignor to Chrome Crankshaft Co., Los Angeles, Calif.
An anode for plating a rotating crankshaft is described.
1 claim.

2,940,018, 6/7/60—PRINTED CIRCUITS—W. G. Lee, E. Chicago, Ind., assignor to General American Transportation Corp., Chicago, Illinois.
The use of electroless nickel as an inner layer of a printed circuit followed by copper is claimed.
9 claims, figure.

2,940,225, 6/14/60—BUFFING WHEEL—F. E. Hendrickson, S. Elgin, Illinois.
A plurality of flexible buffing elements mounted to a central disc through a T-shaped bracket by a cup-shaped member in the fold of each element is claimed.
5 claims, figure.

2,940,867, 6/14/60—IMMERSION TINNING—M. A. Streicher, assignor to E. I. du Pont de Nemours & Co., Wilmington, Del.
After roughening the steel sheet, immerse in a solution of:

Stannous sulfate	10–40 g/l
Sodium bisulfate	100–250 g/l
Non-ionic W. A.	30–100 g/l

9 claims.

2,940,870, 6/14/60—HOT DIP GALVANIZING—A. Baldwin, assignor to Hanson-Van Winkle-Munning, Matawan, N. J.
This method of galvanizing involves wetting in zinc ammonium chloride solution followed by drying, then flux in molten bath of 40–80 per cent $ZnCl_2$ and 15–45 per cent KCl (under 700F) followed by immediate passage into the molten zinc.
7 claims.

2,940,877, 6/14/60—PAINT STRIPPER—L. Jaffe and W. L. Harris, assignors to General Motors Corp., Detroit, Michigan.
A sodium hydroxide stripper containing a hydroxy benzene and gluconates saccharates and similar organics is described.
8 claims.

2,940,911, 6/14/60—ELECTROREFINING BORON—A. A. Uchiyama, et al., assignors to American Potash & Chemical Co., Delaware.
The method consists of electrolyzing in a fused salt bath with crude boron as the anode.
8 claims

2,940,917, 6/14/60—ANODE—J. Dyson, assignor to Chrome Crankshaft Co., Los Angeles, Calif.
An anode for plating a rotating crankshaft is described.
1 claim.

2,941,656, 6/21/60—BARREL—William H. Jackson, The Udylite Corp., Detroit, Michigan.
A barrel with an automatic door panel is explained.
10 claims, figure.

2,941,875, 6/21/60—ETCHING—A. Amaya, assignor to Sony Corporation, Tokyo, Japan.
Germanium can be etched in a 0.01–5 per cent solution of hypochlorite by bubbling CO_2 into the solution to adjust the *p*H to 6.5–6.6.
2 claims.

2,941,902, 6/21/60—ELECTROLESS NICKEL—P. Talmey and W. J. Crehan, assignors to General American Transportation Co., Chicago, Ill.
A method of circulating and filtering an electroless nickel bath is described.
23 claims, figure.

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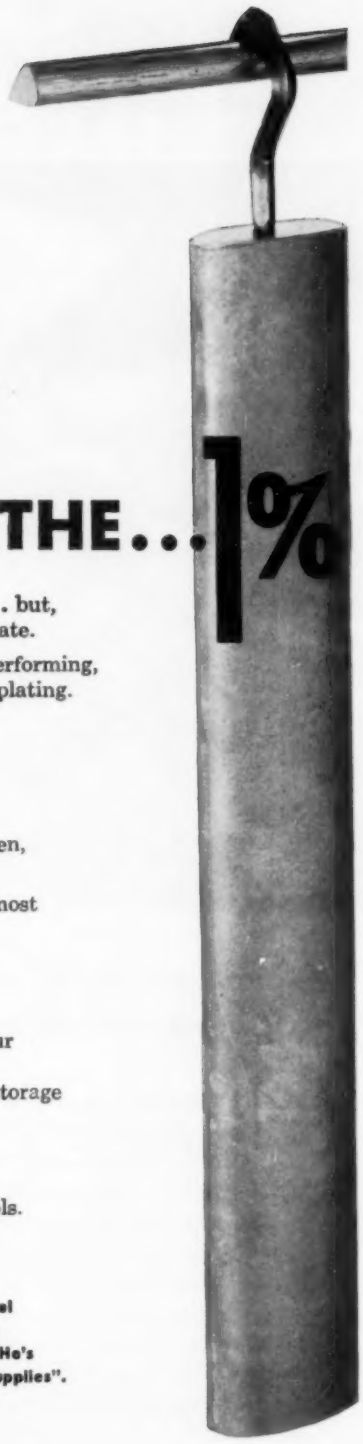

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SEALING ANODIZED ALUMINUM.
Fred Pearlstein.
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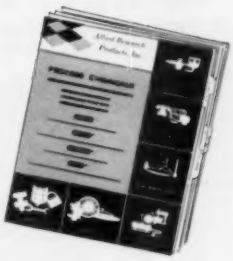

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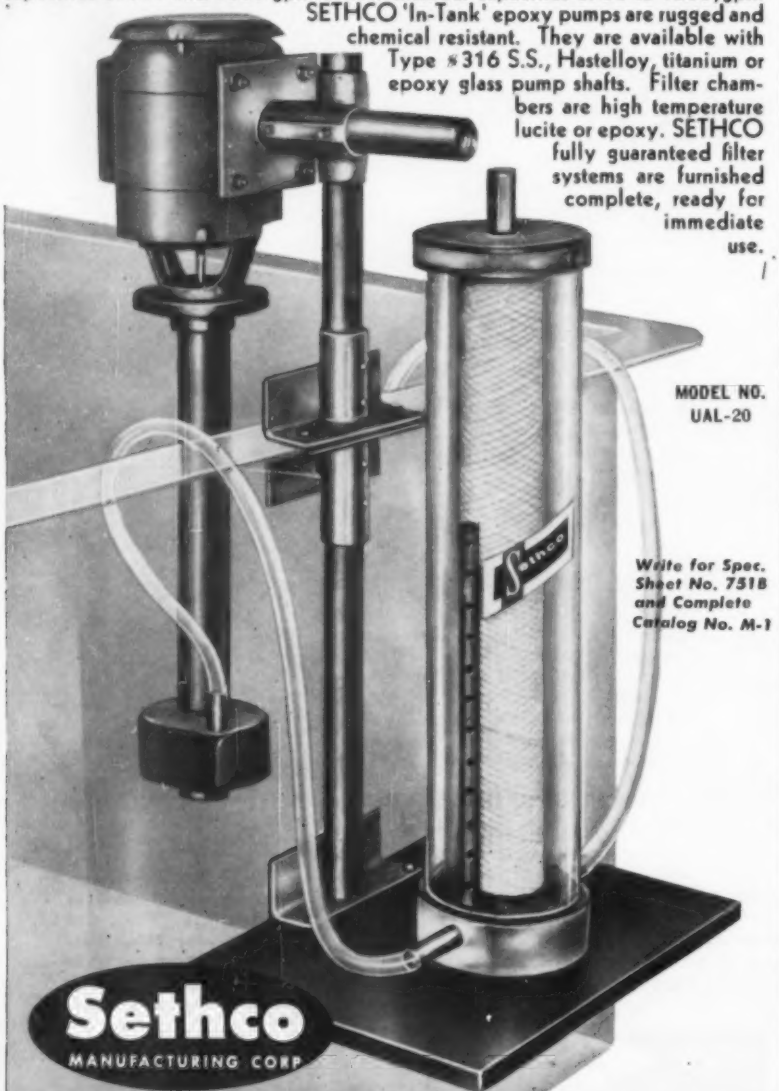

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R. Pinner.
Metal Finishing, *59*, No. 8, August 1960, pp. 36–39, 43.

b. *FINISHING POINTERS—SILVER PLATING OF ELECTRICAL CONTACTS BY IMMERSION.*
Isidore Geld.
Metal Finishing, *59*, No. 8, August 1960, p. 53.

c. *HOW TO FINISH MAGNESIUM.*
Dr. John A. Stevens.
Products Finishing, August 1960, pp. 74–82.

d. *PORCELAIN ENAMEL ADHERENCE STUDIES.*
Nelson F. Murphy.
Products Finishing, August 1960, pp. 90–96.

133. **NICKEL**
THE INCORPORATION OF SULFUR IN ELECTRODEPOSITED NICKEL, USING THIOUREA AS A BRIGHTENER AND LEVELER.
G. T. Rogers and M. J. Ware. Atomic Energy Research, and R. V. Fellows, Wilmot Breeden Lab.
Journal of the Electrochemical Society, *107*, No. 8, August 1960, pp. 677–682.

The following are metallurgical abstracts taken from The Journal of the Institute of Metals, June 1960, pp. 669:

ALUMINUM

Electrodeposition of Aluminium from Hydride Electrolytes. J. Elze, G. Lange, and D. Meyer (Metall, 1959, 13, (6), 541–546)—The structure of a superpurity Al coating deposited from Couch and Brenner's electrolyte (J. Electrochem. Soc. 1952, 99, 234; M.A., 20, 181) was investigated. In a pure electrolyte, the deposit consisted of individual crystal aggregates, the number of which increased with c.d. to form a compact layer at and above 40m amp/cm². No directionality could be detected. Some organic substances coarsened the deposit, others (e.g. 5,6-benzoquinoline) induced a spiral growth of crystals resulting in a peculiar surface appearance. At a temp.-dependent threshold value of c.d., the spiral growth gave way to a compact and dense cryst. layer.

BERYLLIUM

The Electrodeposition of Beryllium from Non-Aqueous Solutions. I. A. Menzies, D. L. Hill, and L. W. Owen (J. Less-Common Metals, 1959, 1, (4), 321–330)—No metal deposition at the cathode occurred when soln. of $BeCl_2$ in anhydrous liq. NH_3 were electrolysed at −33C, using Pt and Be anodes and Cu and Be cathodes. However, Be is anodically dissolved and cathodically deposited with a purity of 99.5 per cent in fused eutectic mixtures of LiCl-KCl and NaCl-BeCl₂. The process is discussed. 34 ref.

CHROMIUM

On the Deposition Potential and Reaction Mechanism for the Deposition of Chromium from Complex Trivalent Chromium Sulphate Solutions. Willi Machu and M. F. M. El-Ghandour (Werkstoffe u. Korrosion 1959, 10, (10), 617–621). Deposition of Cr from $Cr_2(SO_4)_3$ soln. with and without addn. of $(NH_4)_2SO_4$ and $CO(NH_2)_2$ was investigated by means of current/voltage curves and by change of c.d. and potential with time. Cr deposition takes place only in the complex soln. and with a negative potential of −1.06 V. A mechanism is given which depends on the formation of a layer of Cr hydroxide acting as a diaphram. The film formation is conditional on pH and c.d.

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J. Electrochemical Society
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New York 23, N. Y.

J. Institute of Metals
17 Belgrave Square
London, S.W. 1, England

Materials in Design Engineering
430 Park Avenue
New York 22, N. Y.

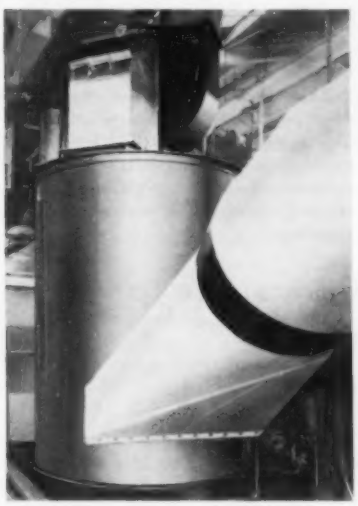
Metal Finishing
381 Broadway
Westwood, N. J.

Products Finishing
431 Main St.
Cincinnati, Ohio

EQUIPMENT AND SUPPLIES

E—1001. FUME SCRUBBER—Installation by Heil Process Equipment Corp. consisting of duct, fume scrubber and exhaust fan handle corrosive fumes in the cleaning and plating department.

Nitric phosphoric acid fumes from aluminum bright dip process tank are caught in a canopy-type hood built entirely of Rigidon plastic, and carried to the fume scrubber through 36-in. diameter plastic duct shown at the right.



The fume scrubber, of 16,250 cfm capacity is of fabricated steel construction lined with Heilastic No. 752 (a sheet vinyl lining). It is filled with plastic packing, and treats the fumes as they pass through with a recirculating caustic neutralizing solution.

♦

E—1002. FLAKE PROTECTIVE COATING—Fiberglas Flake protective coating, a spray coating providing a corrosion-resistant surface to metals, wood and concrete, has been developed by Owens-Corning Fiberglas Corp. Concurrently, a spray gun unit especially designed for applying the new Owens-Corning product has been developed by the De Vilbiss Co.

Accelerated weathering tests have shown virtually no deterioration of the coating. The coating, a homogeneous mixture of Fiberglas Flake, resin, fillers, accelerator and pigment (if desired), can be utilized in many fields where corrosion is a major problem.

No mixing is required on the job since fillers and accelerators are incorporated in the product.

A 20-mil thick coating of this new product has 50 layers of Fiberglas Flake, roughly the equivalent of getting 50 coats of paint in one application.

The basic De Vilbiss equipment for applying Fiberglas Flake protective coating consists of a pump, spray gun, air compressor, five-gallon pressure tank, air regulator, flow meter, and air and fluid hoses.

♦

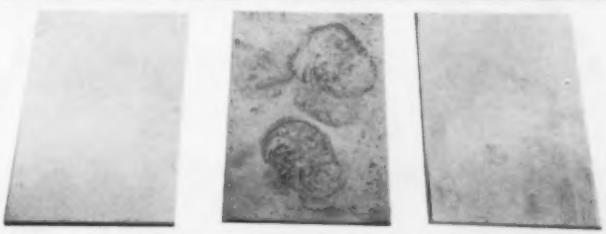
E—1003. WATER COOLED RECTIFIER—The Semiconductor Div. of Sarkes Tarzian Inc. announces the availability of a series of water cooled 1000 amp rectifiers.

This series is designated as ZB and covers a voltage range from 50–200 peak inverse volts. Water cooling allows very small size and the total volume required for each device is less than 60 cu in. Three phase connection provides a current rating of 2500 amp, without paralleling units and 5000 amps with six phase connections.

♦

E—1004. VIBRATORY FINISHER—A new tub-type vibratory finisher built by Vibraslide, Inc., is announced by M-F Equipment Co., United States sales agent for Vibraslide finishers, and offers variable amplitude from 0 to 3/8 in.

Now! MAXIMUM SMUT REMOVAL



After cleaning in Anodyne HD | Before cleaning | After cleaning in "X"

A comparison showing the superiority of Kelite Anodyne HD over a typical anodic steel electrocleaner.

at high current density with

KELITE ANODYNE HD

in fully automatic operations

Anodyne HD provides high conductivity and a superior ability to remove oxide and carbon deposits from steel and buffed copper. Even at current densities up to 150 amperes per square foot, this anodic cleaner does not attack the metal being cleaned. A foam blanket is generated to trap alkaline spray produced in electrolytic cleaning. This foam blanket is brittle so that it breaks before becoming too thick for the automatic equipment.

For further information or a Product Bulletin, contact the nearest Kelite office listed below.

KELITE CORPORATION

• Los Angeles 12 • Chicago 45 • Berkeley Heights, N. J.

Amplitude is claimed to be positive, generated by mechanical cam action, and is easily adjusted without disassembly of the unit. Once adjusted, it does not vary as a result of changes in frequency or weight of load, and is not affected by the reaction of the suspension system.

The tub-type work container is easily removed from the machine without disassembly of other components, and all subunits are easily accessible.

♦

E—1005. MUFFLE OVEN—A new, unique modular muffle oven utilizing the advantages of infrared heating by focusing all the heat directly on the work as it passes through an inner cylinder has been announced by Infrared Systems, Inc. This device provides high-speed heating with close temperature control for curing insulation on wire or cable, for sintering Teflon, and for heat treating rods, bars, tubing, wire and cable.

The inner cylinder is a high-emissivity surface generating infrared radiation. Resistance wire elements are utilized to bring the surface to radiation temperature. The unit can be held constant at any temperature within close limits, with interior temperatures as high as 1500°.

♦

E—1005. NICKEL COATING—The Seymour Manufacturing Company has announced the invention of new improvements in high-level nickel plating. The product is being marketed by Seymour under the name of Hi-Thro. (Patent Applied For). It was designed to provide the base nickel layers with an inherent receptability to an outer bright nickel coating. This unique process eliminates the necessity for a special intermediate step now in common practice.

Conventional procedures provided for an initial treatment of the metals, prior to the application of bright nickel surface layers. This extra step required a special activating treatment which rendered the base nickel receptive to the electrodeposition of the bright nickel surface layer. Hi-Thro eliminates this step.

♦

E—1007. DEBURRING MACHINE—A new Acme semi-automatic deburring machine for finishing circular or related shaped parts is available from Acme Manufacturing Co.

Basically, the deburring machine consists of an adjustable single spindle Acme type B-61 semi-automatic machine that positions and rotates the parts, and Acme L-8-L adjustable lathes positioned around the machine to perform the deburring operations.

Parts to be deburred are manually loaded on a plain type chuck which is rotated during the deburring operation. A timer controlled air cylinder arrangement positions the part into contact with the deburring lathes. At the end of the deburring cycle the air cylinder pull back arrangement automatically retracts the parts out of contact with the deburring lathes for part unloading and reloading operations.

♦

E—1008. ALKALINE CLEANER—Development of an alkaline platers' cleaner that eliminates the hazardous acid pickling process for rust removal in electroplating has been announced by Turco Products, Inc.

Called "Surj," the new product is said to combine heavy duty cleaning abilities with light rust removing properties for use electrolytically or as a soak tank cleaner. Because of its high conductivity in solution, "Surj" cleans the surface of the work and penetrates deeply into the pores to remove in addition to the rust any grease, oil, buffing compound or fingermarks present, leaving a chemically clean surface.

♦

E—1009. NICKEL CHLORIDE—Hanson-Van Winkle-Munning Co. has announced the availability of a new instant liquid nickel chloride, used in place of dry nickel chloride. It offers nickel platers three advantages over the dry material; eliminates dissolving problems, ease in handling and better storage.

Because of H-VW-M liquid nickel chloride's miscibility, tedious dissolving problems are said to be eliminated. The solution requires no stirring or pre-mixing. Platers need only pour the required amount into the plating bath to bring the nickel chloride content up to proper level.

♦

E—1010. TANK LINING—The addition of Penton chlorinated polyether tank lining to its series of corrosion-resistant lining materials is announced by The U. S. Stone-

- Carefully-controlled standards of purity and uniformity
- Orders filled promptly
- Material easy to handle in sacks and fiberboard drums

PHELPS DODGE REFINING CORP.
300 PARK AVENUE, NEW YORK 22, N. Y.

ware Co. Providing corrosion-resistance even at elevated temperatures, the lining is claimed to afford economical protection against virtually all organic and inorganic agents, resisting all inorganic acids except fuming nitric and fuming sulfuric.

Physically, Penton lining material is tough, strong, and exhibits dimensional stability, assuring a long service life free from expensive shut-downs for maintenance or repairs.

Extruded in form roll by The U. S. Stoneware Company from a resin developed by Hercules Powder Co., Penton tank linings are installed by factory-trained applicators located throughout North America.

♦

E—1011. POLYETHYLENE ADHESION PROMOTER—Articles made of polyethylene, polypropylene plastics, heretofore difficult to lacquer, bond, print and metalize, can now be processed by a 30-second pretreatment dip in Chemclean Products Corporation's "Poly-Prep."

A new concept in treating these inert plastics, Poly-Prep is not a coating but a chemical solution which is said to activate the surface of both polyethylene and polypropylene—thereby, promoting adhesion.

♦

E—1012. HAND CLEANER—A new hand cleaner, under the label of New Liquid—Little Doc Disolvit Industrial Hand Cleaner has been announced by The Schaffner Mfg. Co., originator of the waterless hand cleaner.

New Liquid Disolvit was especially developed to clean hands of the soil acquired in the metal finishing industry. It is claimed to remove polishing grease, buffing compounds, die grease, oils, plating soils, etc., with or without water. The 100-ounce container, with its patented built-in dispenser, can be mounted in its patented wall bracket anywhere in the plant.

♦

E—1013. QUARTZ HEATING PANELS—These new panels manufactured by The Cleveland Process Corp. contain one to four Clepcofused, quartz, radiant heating elements. They come in standard lengths 2 to 6 ft and from 4 to 12 in. in width. Wattage can vary to requirements. Clepco Infra-red heating element can be varied up to 1700 F.

Two new basic patents have been granted. One on a new bracket connection for easy installation, repair or replacement. The other patent covers an ignition proof metal cap which seals both ends of the tubes. Panel ends have ceramic stand-off connectors with stainless steel studs and lockwashers and nuts and can be fitted in any oven.

♦

E—1014. DEBURRING COMPOUND—A new compound that combines moderate alkalinity with abrasives to deburr metals in tumbling barrels has been introduced by Oakite Products, Inc.

The new compound, Oakite FM 182, incorporates 40- to 80-mesh abrasive to speed cutting action, and so shorten deburring cycles in the finishing operation. It has no adverse chemical action on metals, and in fact, often enhances the color of the pieces. It may be used in a range of 4 to 48 oz/gal of water, at room temperature, and for times varying with the nature of the work.

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MANHATTAN RUBBER LINING PROTECTS COSTLY PICKLING AND PLATING EQUIPMENT ...Permanently

STOP CORROSION STOP CONTAMINATION

- THICK, MULTIPLE CALENDERED SHEETS
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- NATURAL OR SYNTHETIC RUBBER
- WON'T HARDEN, CRACK OR OXIDIZE
- TESTED UNDER HIGH VOLTAGE

Be *certain* of lifetime protection for your costly equipment and protection against contamination of expensive plating baths. Specify Manhattan lining on your next tank lining job.

Photo courtesy Hanson-Van Winkle-Munning Co.

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MANHATTAN RUBBER DIVISION • PASSAIC, NEW JERSEY

RM1039-R

PERSONALS

J. JUSTIN BASCH has been elected second vice president, and **WILLIAM A. BALTZELL**, vice president of Oakite Products, Inc.

Mr. Basch joined Oakite in 1925 as representative in Pittsburgh. He became Philadelphia division manager in 1930, and has been vice president in charge of marketing since 1958. He will continue to be responsible for the firm's marketing and research and product development programs.

J. J. Basch

W. A. Baltzell

Mr. Baltzell has been with Oakite since 1941, first as sales representative in Dallas, then as manager of the company's southern division. In 1958 he was appointed industrial sales manager, which position he will continue to hold.

♦

DR. HIRAM PAUL JULIEN, formerly head of research on static electricity at Esso Research and Engineering Company, Linden, N. J., has been appointed manager of advance studies department in the Technical Branch of The Carborundum Company's Bonded Abrasives Division.

Dr. Julien holds an AB degree in chemistry from DePauw University and a PhD in physical chemistry from Massachusetts Institute of Technology.

♦

PHILIP D. CAINE, formerly New England manager for Becco Chemical Division of Food Machinery and Chemical Corporation, has been promoted to sales promotion manager for the Division, with headquarters in New York City.

In his new assignment, Mr. Caine will have charge of Becco's advertising and sales promotion activities, including market-development for new products and new applications of Becco's present line of peroxygen chemicals.

Mr. Caine graduated in 1942 from Lowell Textile Institute. Immediately volunteering for service with the U. S. Navy, he rose to the rank of Lieutenant-Commander by the time of his discharge, in the spring of 1946.

He joined Becco in January 1947, and after training at headquarters in Buffalo, was assigned as a sales representative in the New England territory, becoming New England manager in 1953.

♦

HARRY M. GILL has been named advertising and sales promotion manager for The Diversey Corporation.

For the past year and a half Mr. Gill has been midwest sales representative for *Chemical Processing* magazine. Previously he was advertising manager for Young Radiator Company, Racine, Wis.

♦

JOHN B. HOLLAND, of Birmingham, Michigan, has been appointed Automotive Division manager of Oakite Products, Inc.

Mr. Holland comes to Oakite after 13 years with the Ford Motor Company, where he was production engineer, and four years with General Motors. He was educated at Wayne University and Detroit

high **TEMPERATURE PROTECTION**

Barrett Sulfamate Nickel withstands 2300° F. temperature as these two nickel plated copper discs indicate after exposure to thermal shock in a solar furnace.

The top disc, exposed for 2 seconds, shows deterioration of Watts type nickel. The bottom disc, exposed four times longer and plated with Barrett Sulfamate Nickel, indicates no deterioration. Both discs were plated with a 0.007" deposit.

The ability of Barrett Sulfamate Nickel to withstand the high temperature, due to lower porosity and denser deposit, resulted in plating the first successfully recovered nose cone with this process.

Moral: Where high temperature protection and a stress free nickel deposit is required . . . use Barrett Sulfamate Nickel.

Request Bulletin SN-2

BARRETT
chemical products company, inc.
Shelton • Connecticut

College of Applied Sciences. He will make his headquarters in the General Motors Building in Detroit, but will travel extensively to other automotive centers.

♦

HARLIS E. MARTIN has been assigned to Rock Island, Illinois; **CHARLES W. PEARCE** to Miami, Florida; **KEITH D. JONES** to West Indianapolis; and **DOUGLAS W. VONDERHAAR** to East Cincinnati, as technical representative of Oakite Products, Inc.

H. E. Martin

C. W. Pearce

K. D. Jones

D. W. Vonderhaar

The new representatives completed an intensive eight-week training program at Oakite's New York laboratories and in the field before undertaking their new assignments.

♦

THOMAS KOHLER, formerly applications and sales engineer with Allied Research Products for the past seven years, has been named New York State resident sales engineer for Sel-Rex Corp., Nutley, N. J. In his new assignment, Mr. Kohler will report to **RENE SONNENFELDT,** Sel-Rex's representative in the area for several years, who has been promoted to district manager. Messrs. Sonnenfeldt and Kohler will reportedly handle semiconductor rectifier equipment and automatic metal processing machinery, manufactured by The Meaker Co., a wholly-owned subsidiary of Sel-Rex.

Mr. Kohler, who holds a degree in chemistry from St. Lawrence University, has held technical, engineering and sales positions in industry for over 15 years. His background includes positions with U. S. Gypsum, production chemist; Sheffield Farms, production supervisor, organic chemicals; Cherry-Burrell, metallurgical

T. Kohler

R. Sonnenfeldt

chemist; and Wall Wire Products Co., where he was plating supervisor for over five years.

A resident of Fayetteville, New York, Mr. Kohler will cover Western and Northern Pennsylvania, as well as Western New York State, for his company.

Sel-Rex's new district manager for New York State, René Sonnenfeldt, is no stranger to the electroplating industry and to electroplating facilities of major electronic concerns in his assigned territory, having provided sales engineering services in the area for the past four years. A chemical engineering major at the university in his native Utrecht, Holland, Mr. Sonnenfeldt gained considerable "trouble shooting" experience with Dutch companies as a service and sales engineer, which gave him first hand knowledge of electroplating and metal finishing as practiced in Europe. In addition to enabling him to provide an unusual service to customers, this experience has formed the basis for an interesting informal talk he has given before several Branches of the American Electroplaters' Society.

Prior to joining Sel-Rex in 1955, Mr. Sonnenfeldt held technical positions with American Plating Inc., Zelienople, Pa., and Bart Laboratories, in Belleville, New Jersey.

♦

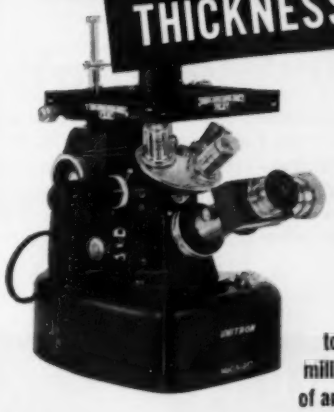
JOHN W. WEITZEL has been appointed technical sales representative in Eastern Pennsylvania; Delaware and Maryland by Heatbath Corporation. Mr. Weitzel is a graduate of Saint Joseph's College and was formerly associated with Diversey Corp. He will have headquarters at 930 Bridge Street, Philadelphia 24, Penna.

J. W. Weitzel

N. M. Thomas

WHY GUESS ?

MEASURE PLATING THICKNESS



to a millionth of an inch

Your profits depend on meeting tight specifications, maintaining quality control and reducing rejects. Can you afford to guess at plating thickness when it is so easy to *measure and be sure*?

UNITRON'S PL-MEC PLATER'S MICROSCOPE substitutes facts for uncertainty. The plated deposit is observed through a Filar Micrometer Eyepiece and measurements are read directly from a micrometer drum. This compact microscope is easy to use, portable around the shop and has a built-in light source. It also doubles as a metallurgical microscope for examining grain structure etc. at magnifications of 25X-1500X. Permanent photographic records may be made using an accessory 35mm. camera attachment and provide valuable legal protection for subcontractors.

UNITRON'S PLATER'S MICROSCOPE will save its initial cost many times over. Prove this for yourself — as so many firms in the plating industry have done—by requesting a **FREE 10 DAY TRIAL** in your own plant. There is no cost and no obligation.

Above: Accessory camera attachment. Left: Observing the plated deposit.

$468 Model PL-MEC complete with all optics and standard accessories	As above with built-in camera attachment, but without 35mm. camera back: **$540**

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Company_____

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NOEL M. THOMAS has joined The U. S. Stoneware Company's Plastics and Synthetics Division and will handle inside sales and sales correspondence of the Akron, Ohio firm's Tygon flexible plastic tubing. A graduate of Kent State University, Mr. Thomas was previously with the International Sales Division of The B. F. Goodrich Co.

♦

SIDNEY FUHR has been appointed as technical sales representative for Frederick Gumm Chemical Company, covering Northern New Jersey. His office will be at 538 Forest Street, Kearny, N. J.

Mr. Fuhr attended City College of New York and the Polytechnic Institute of Brooklyn where he majored in chemical engineering. His practical experience includes almost ten years of production supervision in the metal finishing field. He then joined the Frederick Gumm Chemical Co. as assistant to the technical director where for the past seven years his time was devoted to product development and customer service.

W. G. Brown

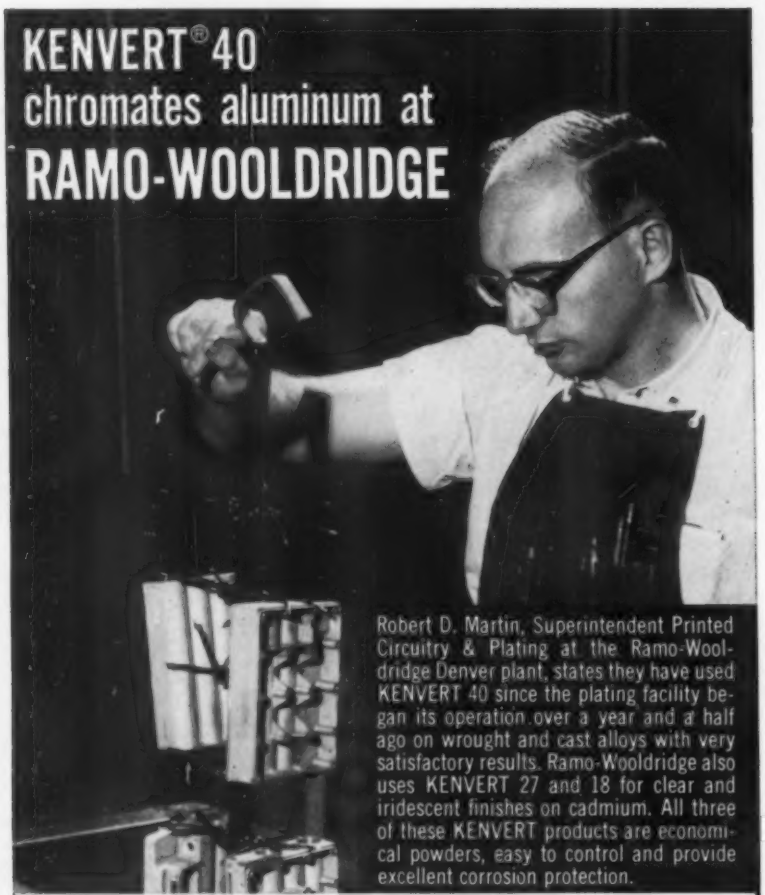
S. Fuhr

WILLIAM G. BROWN has been promoted to vice president and sales manager of The Seymour Manufacturing Co.

In 1945 Mr. Brown joined Seymour as metallurgist and trouble-shooter, after serving with the Western Brass Co. and American Brass in Canada for a number of years. Three years later, he became works manager of the Phosphor Bronze Corporation, and in 1951 was appointed a research engineer for the Olin Mathieson Corporation, engaging in research in metals.

Mr. Brown returned to Seymour in 1956, becoming successively production manager, plant superintendent, and works manager. He held the last position until his current appointment.

KENVERT® 40
chromates aluminum at
RAMO-WOOLDRIDGE



Robert D. Martin, Superintendent Printed Circuitry & Plating at the Ramo-Wooldridge Denver plant, states they have used KENVERT 40 since the plating facility began its operation over a year and a half ago on wrought and cast alloys with very satisfactory results. Ramo-Wooldridge also uses KENVERT 27 and 18 for clear and iridescent finishes on cadmium. All three of these KENVERT products are economical powders, easy to control and provide excellent corrosion protection.

Other KENVERT products for aluminum:
KENVERT 45—non-fuming pickle for aluminum castings
KENVERT 46-EC—non-fuming aluminum bright dip additive
KENVERT SLUFF-OFF® X—buffing compound remover

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C. F. WENTWORTH

C. F. Wentworth, Long Beach, Calif., Pacific Coast manager of the Metal Industries Division of The Diversey Corporation, died August 8 after a long illness.

Mr. Wentworth joined Diversey in 1946 as the company's sole West Coast representative serving the metals industries. At the time of his death he supervised all Diversey metal industries operations in California, Washington and Oregon.

He was a member of the Los Angeles Branch of the American Electroplaters' Society and was widely known throughout the metal industries of the Far West.

CLARKSON MOVES TO NEW PLANT

The Clarkson Laboratories, Inc., manufacturers of specialty chemicals for the metal finishing industry, moved on August 1 from its old location in Philadelphia, Pa. to its new plant and administrative offices at 1450 Ferry Avenue, Camden, N. J. The new facilities will increase the space available for both research and manufacturing.

Because of the increased capacity available, Clarkson is expanding its jobber representatives. In order to provide better service in the west, the Clarkson plant at 2655 Ingalls Street, San Francisco, Cal. has just been expanded.

♦

SPE TO HAVE NEW PLASTICS PUBLICATION

The Society of Plastics Engineers announces publication of a new quarterly scientific journal, *SPE Transactions*, commencing in January of 1961. This new publication will contain articles on basic polymer theory, science, and engineering. It is available to both members and nonmembers of the Society on a subscription basis and will contain no advertising.

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year after year has manufactured Reliance Plating, Polishing Equipment, Supplies for Better and More Profitable Metal Finishing

RELIANCE
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SILICON RECTIFIERS

VARIABLE SPEED
POLISHING LATHES

QUALITY
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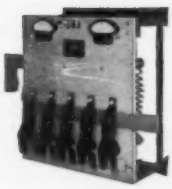
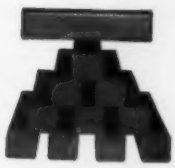
SERVICE

RELIANCE HORIZONTAL PLATING
BARREL. LUCITE, HARD RUBBER OR
BAKELITE CYLINDER. MOTOR—
GEARED [illegible] HEAD



TANK
RHEOSTAT



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COMPOSITIONS
LIQUID • EXTRUDED • MOLDED

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SISAL BUFFS

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LARGE ATTENDANCE EXPECTED FOR DIE CASTING EXPOSITION

An attendance of 10,000 die casting engineers, die casting plant managers, buyers of die castings, metalworking production executives, tool and manufacturing engineers, and design engineers and stylists is expected for the First National Die Casting Exposition & Congress which will be held in the Detroit Artillery Armory from November 8–11, 1960. Invitations are being sent to 30,000 executives, buyers and engineers in industry by the society.

Sponsored by the Society of Die Casting Engineers, the exposition list now includes more than 80 manufacturers of die castings, die casting machines, dies, die steels, casting metals, production and finishing equipment, die casting supplies and die casting services.

The technical congress which is being held at the Detroit Artillery Armory in conjunction with the exposition includes 30 technical papers by authorities in the field. The sessions will deal with such general subjects as die design, die building, metallurgical developments, what's ahead in die castings, competition to die castings, cost and profit, quality control and vacuum die casting.

According to John L. MacLaren, chairman of the affair, the advance registrations and comprehensive list of leading manufacturers who are exhibiting points to a most successful first exposition and congress for the society.

All persons registering for the technical congress will be given a bound volume including all of the technical papers at the conclusion of the affair. Technical sessions at the congress are held every day from 9:30 to 12:00 noon and 1:30 to 4:00 in the afternoon.

Plans have been completed for an extensive banquet affair on Thursday evening, November 10, which will be held in the Veteran's Memorial Building in Detroit's new and modernistic waterfront development.

Joseph G. Rayniak, director and past president of Outboard Marine Corporation of Waukegan, Illinois is scheduled to be one of the speakers for the evening. Noted humorist Art Briese of Hot Springs, Arkansas will be the after-dinner speaker. Also at the banquet the Society of Die Casting Engineers will present its first SDCE Achievement Award to an individual for outstanding achievement in the application and development of the die casting process.

BATTELLE BROCHURE DESCRIBES CONTRACT RESEARCH

The first in a series of illustrated statements on contract research for industry has just been published by Battelle Memorial Institute, Columbus, Ohio. Titled "Procedures of Contract Research for Industry", this first statement serves as a point of departure for the series, which is oriented toward executives in industry who have varying degrees of decision-making responsibility for research and development programs.

"Procedures of Contract Research for Industry" describes in a step-by-step manner the relationship existing between the client and the research institute, beginning with the initial meeting of the two parties and progressing beyond the successful completion of a specific project. Phases of this relationship discussed include the preliminary conferences between the client and the research institute that precede the initiation of a research project; conferences among institute specialists to define the research objective and evaluate possible approaches; the contractual agreement between the research institute and the client; actual conduct of the research; reports to the client while the research is in progress; and the presentation of final results, as well as follow-up services provided by the institute.

In inaugurating the series, Battelle points out that while the combined facilities of the nation's contract research organizations are impressive, in actual number there are few such groups. As a result, many executives with a responsibility for managing research programs have only a limited understanding of contract research procedures. The series is an attempt to more clearly define the character of the contract research organization and the procedures it employs in meeting the growing demands of industry for research.

Other statements to follow in the series will cover the administrative controls of contract research by which the client maintains control of the project's objective, scope, timing and cost, but is relieved of technological administration.

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2. The book on "Hydrogen Embrittlement in Metal Finishing" edited for AES by Dr. Harold J. Read of Pennsylvania State University.

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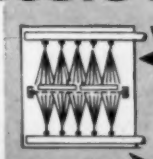

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BRANCH NEWS

Total AES Branches U. S., Canada, Australia, October 1, 1960—59.

DETROIT

Branch Stag Day Delights Members and Guests

The annual Detroit Branch Stag Day was held on August 6, at Glen Oaks Country Club.

The Detroit Branch was pleased to have among the 700 attending, our many friends from neighboring Branches: Saginaw Valley, Central Michigan, Grand Rapids, Toledo and St. Joseph Valley.

This year there were several innovations in the party under the able direction of Chairman **Arnold Emmerick,** that old veteran of Detroit Stag Day promotion, and his enthusiastic committee.

All in attendance were pleased with such major changes as the banquet style steak dinner and the special floor show, a new door prize policy which provided such gifts as a television set, bicycle and several other valuable gifts.

Guy A. Cummings Jr.
Secretary-Treasurer

GRAND RAPIDS

Annual Meeting, Jan. 21, to Feature Quality Control Symposium

We are at the threshold of a promising new year of activity for the Grand Rapids Branch. At a meeting of the executive board of our Branch on August 22, the date for our annual Education Session and Banquet was set for January 21, 1961. As in past years, this affair will be held in the Pantlind Hotel, in downtown Grand Rapids, with a program consisting of a morning Educational Session, noon luncheon, afternoon Educational Session with a Banquet and entertainment for members and their ladies in the evening. This year we are planning on having a Symposium on Quality Control, as it pertains to the evaluation of plated articles. It is our intent to bracket both the appliance and automotive fields in this category.

Our first monthly Branch meeting was held September 9, 1960, at Scotties Restaurant, in south Grand Rapids, where we have continued to meet for the last three years. Our speaker was **R. Gray,** of Industrial Filter and Pump Corporation.

O. D. Hoxie
First Vice President

SAN FRANCISCO

Plan First Annual Branch Educational Session

The August 11 meeting of the San Francisco Branch was called to order by **Guy Condrott** who introduced three guests.

Calvin E. Snelgrove, secretary-treasurer, introduced the speaker, **George L. Kresa,** sales representative for Kalman Floor Co. Mr. Kresa spoke on "Epoxy Floor Topping in the Metal Finishing Industry." Following the talk, there was a long question and answer session regarding details for preserving plating room flooring.

During the business meeting, Guy Condrott called for our national convention delegates' report on the Supreme Society business meeting in Los Angeles.

Mr. Condrott discussed the recent regional meeting he attended, pointing out the preparations being made to have speakers tour the West Coast from San Diego to Seattle-Vancouver area on an organized speakers' program.

A motion was brought before the membership, seconded, and carried, to send a letter of commendation to the Los Angeles Branch for the success of the National Convention.

Plans for the First Annual San Francisco Branch Educational Session on Saturday, February 18, 1961, moved a step further forward as committee chairmen were formed as follows: Hotel-food, **J. R. Pattenger;** entertainment, **Fred Huntington;** speaker, C. E. Snelgrove; registration, **Elston Flores;** ticket, **Trevor Harry;** publicity, **John Natwick.**

C. E. Snelgrove
Secretary-Treasurer

SOUTHEASTERN

Tenth Annual Branch Ladies Night

Ladies were honored at the Druid Hills Country Club in Atlanta on August 20 at the 10th Annual Ladies Night of the Southeastern Branch. Platers and their wives came in from greater Atlanta, Jonesboro, Adel, Anniston, Carrollton, Athens (Ga.), Nashville, Greeneville, Tennessee and Greenville, South Carolina. Many new first nighters were recognized this year as the attendance reached up to 53.

The invocation was offered by **Justis Belville** of Jonesboro, Georgia.

The head table featured **Mr. and Mrs. Vince Cashen, Mr. Bruce Taylor, Mr. and Mrs. Clem Hohner, Mr. and Mrs. H. R. Stogner Sr.,** and **Mr. and Mrs. Bob M. Taylor.** Vice President Vince Cashen presided and delivered a short welcome speech. Clem Hohner was recognized as chairman of the Ladies Night Committee. H. R. Stogner Sr. reported on the Los Angeles Convention explaining the reasons why the Dixie Regional request for the 1966 National Convention offered at the Interim Meeting was changed by the Dixie group from the previously agreed and offered location of Atlanta to location in Miami. He went on to say that the convention in Miami will be a Regional affair but will be hosted by the Southeastern Branch. Mr. Stogner closed his report by suggesting informally that Clem Hohner be selected for Convention General Chairman (formal action awaits regular meeting action).

The dinner was a choice between strip sirloin or filet mignon, along with trimmings. Separate tables were arranged to seat eight people with a center aisle leading up to the head table.

Eleven door prizes including a grand prize were donated by ten plating shops: D & L Plating Corp., Carrollton, Georgia; Douglas and Lomason Co., Carrollton, Georgia; Atlanta Plating Works, Atlanta; Production Plating Co., Adel, Georgia; Power Plating Co., La Grange, Georgia; General Time Corp., Athens, Georgia; Carolina Plating Co., Greenville, S. C.; Southern Aluminum Finishing Co., Atlanta, Georgia; Southern Plating Co., Anniston, Alabama; Birmingham Plating Co., Birmingham, Alabama. Eleven lucky numbers were selected from a hat by the lovely Miss Elaine Bledsoe, the numbers were called out by **Bob M. Taylor,** and the gift was handed out by H. R. Stogner Sr. The last number was the grand prize which was a beautiful large soup tureen. The ladies oooed and ahed in typical gesture of enthusiastic suspense; they were really enjoying themselves.

Dancing followed to the musical rhythm of Wes Baxter and his band.

Everyone regretted the unfortunate absence of the Branch president, **Myron M. Randman,** who was seriously ill in a local hospital. Vince Cashen announced that flowers had been sent by the Branch.

Appreciation for the splendid arrangements which led to our largest attended and most enjoyable ladies festival are due to Clem Hohner and his committee: H. R. Stogner Sr., **Jerry LaChappell** and **Harry Pink.**

Robert H. Probert
Assistant Secretary

BRANCH SECRETARIES

Branch News is required of all Secretaries monthly by AES Bylaws. First of the month is Branch News deadline for next PLATING issue. Any items on hand on that date will be carried in that edition. Later arrivals will appear in the issue immediately following. In reporting talks given by speakers before the Branch, please give titles of the talks, the speakers' full identification and any other pertinent information of interest to other Branches and PLATING's broad readership.

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Mohawk Valley: H. C. Zinner, R. D. Turi, K. E. Duck
Montreal: A. A. Titterington
Newark: H. Boillat, F. G. Kelly
New York: A. Chiesa
Seattle-Puget Sound: R. H. Bothel
Member-at-Large: G. M. Page, C. R. Johnson, R. G. Marques

REINSTATEMENTS

British Columbia: G. A. Amos
Pittsburgh: C. H. Walton
Seattle-Puget Sound: A. MacRae
Springfield: M. J. Murray

TRANSFERS

Blue Ridge: S. C. Weathers from Member-at-Large
Cincinnati: R. D. Miller to Cleveland, R. E. Thompson to Grand Rapids
Kansas City: G. G. West to Miami
Milwaukee: E. Montie to Central Michigan
New York: I. Tsu to San Francisco
Pittsburgh: G. Skelly to Member-at-Large, R. E. Woehrle to Chicago
Member-at-Large: G. Skelly from Pittsburgh, S. C. Weathers to Blue Ridge

RESIGNATIONS

Dallas-Ft. Worth: H. L. Wilson
Grand Rapids: F. W. May
Indianapolis: L. C. Hesoun
Montreal: J. Cronin
Newark: C. Holden
Pittsburgh: J. DeLuca, R. Varner, R. N. Wieland
Springfield: A. Zavarella
Toronto: J. J. Fitzsimmonds, J. J. Masterson, H. D. Billings, W. A. Trott, D. V. Humphries, T. Larson
Waterbury: D. W. Flood, A. J. MacDermid, A. H. Stevens
Member-at-Large: B. J. Jones

SUSPENSIONS

Dallas-Ft. Worth: J. L. Godfrey, K. W. Kirsten
Grand Rapids: M. A. Tippman
Indianapolis: R. B. Adams, L. J. Bell, J. E. Beebe, M. Combs, T. G. Gross, W. K. Hall, E. R. Handley, J. F. Hensley, J. E. Hoff Jr., W. W. O'Brien, J. D. Powell, O. J. Sands Jr., A. G. Skinner, R. N. Snyder, J. W. Stilwell, E. E. Taylor, J. A. Wheatley, C. R. Young
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DEATHS

Dallas-Ft. Worth: R. H. Thomas
Grand Rapids: C. M. Fermekes
Philadelphia: E. R. Love

PLATING MAGAZINE

OPPORTUNITY TO AUTHORS

Member or non-member authors of technical and scientific papers on electroplating, metal finishing and allied arts are cordially invited to submit manuscripts of original, unpublished papers to the Editor of PLATING MAGAZINE for review and publishing consideration.

Any such paper accepted and published in PLATING will also be eligible for selection by the Society's Paper Awards Committee for the Carl E. Heussner AES Gold Medal Award; AES Silver Medal; AES Bronze Medal; George B. Hogaboom Memorial Nickel Plating Award; Robert S. Leather Mechanical Finishing Award; Chromium Plating Award; Precious Metal Plating Award of AES, John J. Hanney Memorial Copper Plating Award or the Organic Finishing Award of AES.

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MART

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FUTURE MEETINGS

AMERICAN ELECTROPLATERS' SOCIETY

October 21, 1960—Installation, Memphis-Midsouth Branch, Memphis, Tenn.

October 28, 1960—Executive Board, Hotel LaSalle, South Bend, Indiana.

October 29, 1960—Second Annual Midwest Regional Conference, University of Notre Dame, South Bend, Indiana. St. Joseph Valley Host Branch.

December 2-3, 1960—Detroit Branch Annual Educational Meeting and Banquet, Statler-Hilton Hotel, Detroit, Mich.

December 3, 1960—Executive Board, Hotel Statler, Detroit, Mich.

December 16, 1960—Editorial Board, National Headquarters, Newark, N. J.

December 16-17, 1960—Newark Branch Annual Educational Session and Christmas Banquet, Robert Treat Hotel, Newark, N. J.

January 21, 1961—Grand Rapids Branch, Annual Educational Session and Banquet, Symposium on Quality Control, Pantlind Hotel, Grand Rapids, Michigan.

January 27, 1961—Research Committee, Conrad Hilton Hotel, Chicago, Ill.

January 27, 1961—Cleveland Branch, Annual Educational Session, Technical Center, Cleveland Engineering Society, Cleveland, Ohio.

January 28, 1961—Cleveland Branch, Annual Banquet and Dinner Dance, Carter Hotel, Cleveland, Ohio.

January 28, 1961—Chicago Branch Annual Meeting and Banquet, Conrad Hilton Hotel, Chicago, Ill.

February 3-4, 1961—Third Annual Dixie Regional Technical Session, Hotel Roanoke, Roanoke, Virginia. Blue Ridge Host Branch.

February 4, 1961—New York Branch Annual Educational Session and Banquet, Hotel Statler-Hilton, New York, N. Y.

February 4, 1961—Saginaw Valley Branch Annual Educational Session and Banquet, Frankenmuth, Michigan.

February 4, 1961—Seventh Annual Tri-State Regional Meeting, Deshler-Hilton Hotel, Columbus, Ohio.

February 11, 1961—Eighth Interim Meeting, Supreme Society, Statler Hotel, Hartford, Connecticut. New England Regional Council, Host.

February 18, 1961—San Francisco Educational Sessions and Dinner-Dance, San Francisco, Calif.

March 4, 1961—Philadelphia Branch Annual Technical Session and Banquet, (Tentative Date) Benjamin Franklin Hotel, Philadelphia, Pa.

March 4,	1961—**Dayton Branch 15th Annual Educational Session and Dinner Dance,** Biltmore Hotel, Dayton, Ohio.
March 11,	1961—**Rockford Branch, Annual Meeting,** Rockford, Ill.
April 15,	1961—**Baltimore-Washington Branch,** Annual Banquet and Dance. Presentation of the "Order of the Pot," Baltimore, Maryland.
April 22,	1961—**Twenty-Second Annual New England Regional Meeting,** Hotel Statler, Hartford, Conn.
April 29,	1961—**Milwaukee Branch Annual Educational Session and Banquet,** Schroeder Hotel, Milwaukee, Wis.
May 2,	1961—**Central Michigan Branch Annual Educational Session and Banquet,** Hotel Hayes, Jackson, Michigan.
May 4,	1961—**Empire State Regional Meeting,** Hotel Manger, Rochester, N. Y.
June 18-23,	1961—**48th AES Annual Convention,** Hotel Statler, Boston, Mass.
January 19,	1962—**Ninth Interim Meeting, Supreme Society,** Hotel Marott, Indianapolis, Ind.
June 25-28,	1962—**49th AES Annual Convention,** Schroeder Hotel, Milwaukee, Wis. Sponsorship Midwest Regional Council.
June 24-27,	1963—**50th AES Annual Convention,** Ambassador Hotel, Atlantic City. N. J. Sponsorship Newark Branch.
June 15-18,	1964—**51st AES Annual Convention,** St. Louis, Missouri.
June 16-18,	1964—**6th Industrial Finishing Exposition,** St. Louis, Missouri.
June 28-July 1,	1965—**52nd AES Annual Convention,** Statler Hotel, New York, N. Y.
June	1966—**53rd AES Annual Convention,** Hotel Fontainebleau, Miami, Florida. Dixie Regional Council, Sponsor. Southeastern Branch, Host.

INTERSOCIETY

October 12-14,	1960—**American Vacuum Society,** 7th National Symposium, Cleveland-Sheraton Hotel, Cleveland, Ohio.
October 17-21,	1960—**American Society for Metals,** 42nd National Metal Exposition and Congress, Trade and Convention Center, Philadelphia, Pa.
October 25-27,	1960—**National Association of Corrosion Engineers,** South Central Region Conference, Mayo Hotel, Tulsa, Okla.
November 8-11,	1960—**Society of Die Casting Engineers,** First National Die Casting Exposition and Congress, Detroit Artillery Armory, Detroit, Mich.
Nov. 27-Dec. 2,	1960—**American Society of Mechanical Engineers,** Winter Annual Meeting, Statler-Hilton Hotel, New York City.

AMERICAN ELECTROPLATERS' SOCIETY, INC.
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Publications Committee	Dr. Samuel Heiman

ADVERTISING INDEX

This index is published entirely as a convenience. Every care for accuracy has been exercised. No assurance can be given, however, against inadvertent error.

A

Allied Chemical Corp., General Chemical Division . . Third Cover
Solvay Process Division 1115
Allied Research Products, Inc. 1198–1199
Almco, Queen Products, Division King-Seeley Corporation 1185
American Brass Company 1177

B

Baird Machine Company, The 1195
Baker Company, M. E. 1212
Barrett Chemical Products Co. 1204
Behr-Manning Company 1119
Better Finishes & Coatings, Inc. 1190
Buckingham Products Co. 1136

C

Chemical Corporation, The 1189
Cohn Mfg. Co., Inc., Sigmund 1210
Conversion Chemical Corp. 1206

D

Davies Supply & Mfg. Co. 1196
Diamond Alkali Co. 1118
Diversey Corporation 1120
Dixon & Rippel, Inc. 1178
Draper, Ltd., Robert 1186
Dresser Electric Company 1214
Duggan Masking Devices 1188
DuPont De Nemours & Co., Inc., E. I., Electrochemicals Division 1138–1139

E

Enthone, Inc. 1111

F

Formax Manufacturing Corp. 1210

G

General American Transportation Corp., Kanigan Division 1124

H

Hanson-Van Winkle-Munning Company . . . . . 1166–1167, Fourth Cover
Harshaw Chemical Co., The 1114
Holland & Sons, J. 1209

I

Imperial Industries 1193

K

Kelite Corporation 1201
Kocour Company 1194

L

Lasalco, Inc. 1128
Lea Manufacturing Company 1175
Lea-Ronal, Inc. 1176
L'Hommedieu & Sons Co., Charles F. 1207

M

Macarr, Inc. 1188
Mac Dermid, Inc. 1140
Magnus Chemical Company, Inc. 1208
Malsbary Manufacturing Co. 1191
Metal & Thermit Corporation 1187
Michigan Chrome & Chemical Co. 1116
Munning & Munning, Inc. 1189

N

New Jersey Thermex Co., Inc. 1137
Norton Company 1181

O

Oakite Products, Inc. 1197

P

Phelps Dodge Refining Corp. 1202
Professional Directory 1213

R

Raybestos-Manhattan, Inc., Manhattan Rubber Div. . . . 1203
Reynolds Chemical Products Co. 1122

S

Seeley Co., Inc., E. E. 1209
Sel-Rex Corporation . . . . . Second Cover
Sellers Engineering Co. 1112
Sethco Manufacturing Co. 1200
Seymour Mfg. Company, The 1192
Spraying Systems Co. 1209
Stevens, Inc., Frederic B. 1126–1127

T

True Brite Chemical Products Co. 1210

U

Udylite Corporation, The 1121, 1123
U. S. Stoneware 1182
Unitron Instrument Division of United Scientific Co. 1205

W

Wyandotte Chemicals Corp. 1179

Z

Zialite Corporation 1178

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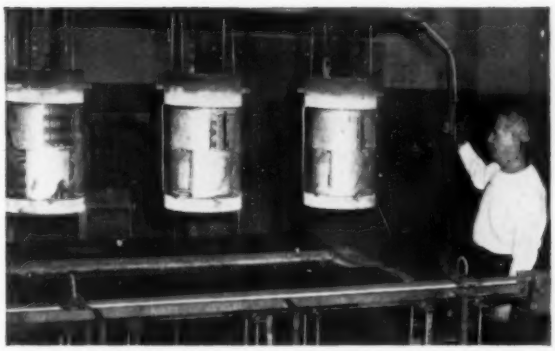

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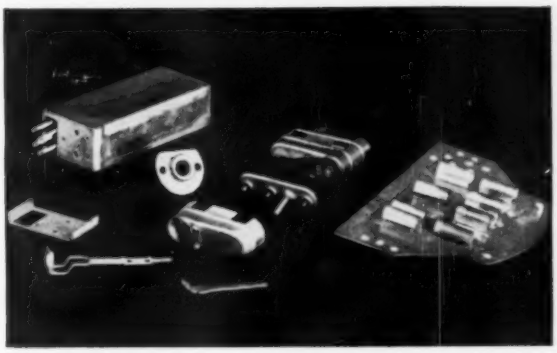
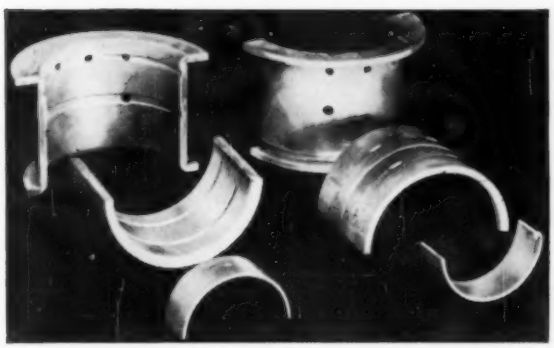


PLATING RADIO AND ELECTRONIC PARTS—B&A Lead-Tin alloys with a high tin content produce non-corrosive coatings of excellent solderability which is not destroyed by long periods of storage before use. Lead-Tin alloy is also used for plating copper wire to produce a more uniform, more readily soldered product.



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PRINTED CIRCUITS—Low cost printed circuits are produced by using B&A Copper Fluoborate for high speed electroforming of thick, high quality circuits; followed by the use of B&A Lead-Tin Fluoborate to give a deposit that may be easily soldered.

IMPORTANT OPERATING ADVANTAGES:
The B&A Metal Fluoborates help you save time, money—get better plating results. They come in ready-to-use concentrated solution form . . . provide excellent bath stability, with minimum of sludging . . . have good covering power . . . give fine-grained deposits of good color . . . and allow ease of maintenance, since anode and cathode efficiencies approximate 100%.

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H-VW-M's New, Improved Levelume 220 is the Brightest Idea Among Today's Bright Nickel Baths

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Levelume 220 is a modified Superlume and is the brightest, highest leveling nickel available *at no premium cost*. Levelume 220 features high brightness with uniformity of brightness on all surfaces, high tolerance to impurities, excellent leveling or scratch-hiding. Levelume 220 is truly the workhorse of all bright nickel plating processes, and meets the requirements of most high-quality bright nickel plating at moderate cost.

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